This is a digital copy of a book that was preserved for generations on library shelves before it was carefully scanned by Google as part of a project to make the world's books discoverable online.

It has survived long enough for the copyright to expire and the book to enter the public domain. A public domain book is one that was never subject to copyright or whose legal copyright term has expired. Whether a book is in the public domain may vary country to country. Public domain books are our gateways to the past, representing a wealth of history, culture and knowledge that's often difficult to discover.

Marks, notations and other marginalia present in the original volume will appear in this file - a reminder of this book's long journey from the publisher to a library and finally to you.

Usage guidelines

Google is proud to partner with libraries to digitize public domain materials and make them widely accessible. Public domain books belong to the public and we are merely their custodians. Nevertheless, this work is expensive, so in order to keep providing this resource, we have taken steps to prevent abuse by commercial parties, including placing technical restrictions on automated querying.

We also ask that you:

+ *Make non-commercial use of the files* We designed Google Book Search for use by individuals, and we request that you use these files for personal, non-commercial purposes.

+ *Refrain from automated querying* Do not send automated queries of any sort to Google's system: If you are conducting research on machine translation, optical character recognition or other areas where access to a large amount of text is helpful, please contact us. We encourage the use of public domain materials for these purposes and may be able to help.

+ *Maintain attribution* The Google "watermark" you see on each file is essential for informing people about this project and helping them find additional materials through Google Book Search. Please do not remove it.

+ *Keep it legal* Whatever your use, remember that you are responsible for ensuring that what you are doing is legal. Do not assume that just because we believe a book is in the public domain for users in the United States, that the work is also in the public domain for users in other countries. Whether a book is still in copyright varies from country to country, and we can't offer guidance on whether any specific use of any specific book is allowed. Please do not assume that a book's appearance in Google Book Search means it can be used in any manner anywhere in the world. Copyright infringement liability can be quite severe.

About Google Book Search

Google's mission is to organize the world's information and to make it universally accessible and useful. Google Book Search helps readers discover the world's books while helping authors and publishers reach new audiences. You can search through the full text of this book on the web at `http://books.google.com/`

PROCEEDINGS

OF

THE AMERICAN ASSOCIATION

FOR THE

ADVANCEMENT OF SCIENCE,

THIRTY-FIRST MEETING,

HELD AT

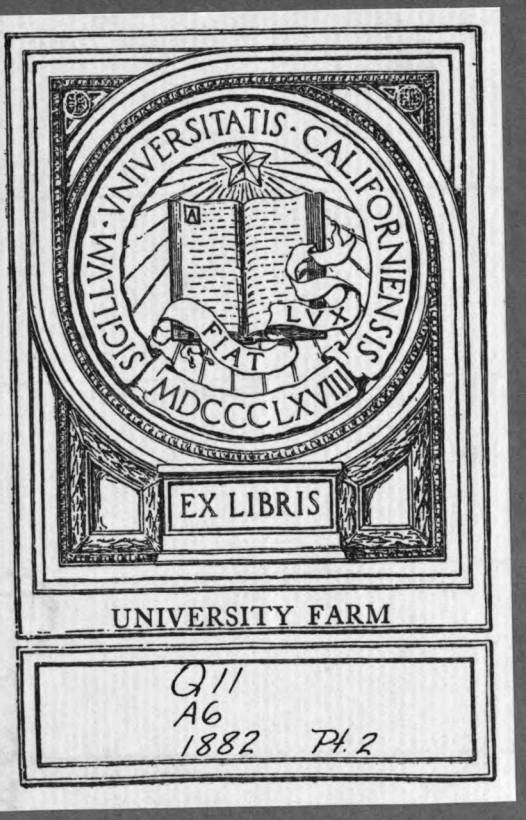
MONTREAL, CANADA,

AUGUST, 1882.

U. OF C. LIBRARY

SALEM:
PUBLISHED BY THE PERMANENT SECRETARY.
1883.

Digitized by Google



QH
A6
1882 Pt. 2

Digitized by Google

Digitized by Google

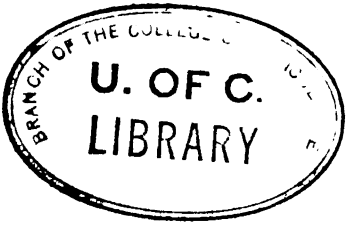
Digitized by Google

Digitized by Google

Digitized by Google

SECTION E.

GEOLOGY AND GEOGRAPHY.



10606

Digitized by Google

Digitized by Google

PAPERS READ.

THE GLACIAL FLOOD OF THE CONNECTICUT RIVER VALLEY. By C. H. HITCHCOCK, of Hanover, N. H.

[ABSTRACT.]

IN 1878, Mr. Warren Upham's report upon the "Modified Drift of New Hampshire" appeared in print. He sketched in full, with maps and sections, the terraces and the kame of the Connecticut valley in New Hampshire and Vermont.

The phenomena were explained by supposing the various deposits to have been accumulated by the flood, attendant upon the melting of the Quaternary ice-sheet. The kame was formed first, and then the higher terraces, which constituted part of an enormous flood plain. When the ice was gone the waters diminished in bulk and the lower terraces were formed. Two kinds of terraces were specially noted: first, the normal highest lateral terraces deposited by the Connecticut flood; second, the deltas of the tributaries to the main stream — the latter being very commonly higher than the others.

Three years later, Prof. J. D. Dana went over the same ground with Mr. Upham's report in hand, in order to procure the additional facts required to estimate the size and velocity of the ancient river. With spirit levels he verified the accuracy of the report, and estimated what the velocity of the current must have been upon the basis of his estimate of the width and depth of the flood. For the country between Massachusetts and Wells river the mean width was thought to average 4,000 feet, and the mean depth 140 feet. The formula for the calculation of the velocity was that given by Humphreys and Abbot.

The mean velocity of the flood from Haverhill, N. H., to Middletown, Ct., must have been over twelve miles per hour; allowing

Digitized by Google

for retardations of various kinds, the rate may be assumed to be ten miles per hour,— this velocity must have been far too great. A study of the materials actually transported indicates an actual velocity of three to four miles per hour. In order to bring the calculated and observed velocities nearer together, it is suggested that the land pitched to the south less than now; for marine fossils occur at increasingly greater elevations from south to north, and consequently the ocean must have been higher in the north. At Montreal it stood 520 feet higher than now; and by proportioning the height to the distance, the Connecticut river at Haverhill must have flowed over a floor 120 feet nearer the ocean level than it is now. By using these figures Professor Dana estimated that when the flood was at its maximum the rate of velocity must have been as much as eight miles per hour. This he allows is much too great, but he does not state how the velocity can have been reduced to the proper limit.[1]

In the statement of the facts, exceptions are taken to Upham's doctrine concerning the method of determining the height of the water. Attention is called to these discrepant views and to the presumption of the correctness of those advanced by Upham, because they reduce the magnitude of the flood and consequently the velocity of the stream, and thus better harmonize our theories with the facts. Dana bases his estimates for the depth of the flood upon the present altitudes of the deltas of the tributary streams. Upham claims that the height of the tributary deltas should not be taken as the measure for the main stream because it is in excess of the truth. The height of the usual lateral terrace between the tributaries is regarded as the more satisfactory measuring rod. This deposit was confessedly made by the main stream.

The following table, as compiled from the sources cited above, will show the differences required for the height of the water according to the diverse theories. Only that part of the river's course between Barnet and Massachusetts is considered.

[1] See Amer. Jour. Sci., III, Vol. XXIII, Feb., March, May, 1882.

Digitized by Google

	River above Ocean.	Highest Normal Terrace above river.	H. N. T. above Ocean.	Deltas above river (Upham).	Deltas above Ocean (Upham).	Deltas above river (Dana).	Deltas above Ocean (Dana).	Deltas above H. N. T.
Barnet.....	452	166	618	223	675	225	677	57 U. 59 D.
Wells river.....	407	123	530	253	660	253	660	130 both
Haverhill.....	392	83	475	238	630	263	655	155 U. 180 D.
Piermont.....	387	78	465	113	500	258	645	35 " 180 "
Orford.....	383	52	435	177	560	247	630	125 " 195 "
E. Thetford.....	378	167	545	157	535	232	610	10 below 65 "
Hanover.....	373	172	545	191	564	207	580	19 U. 35 "
W. R. Junction..	333	177	510	217	550	242	575	40 " 65 "
N. Hartland.....	323	177	500	227	550	242	565	50 " 65 "
Hartland.....	311	189	500	309	620	227	550	120 " 50 "
Windsor.....	304	196	500	236	540	216	520	40 " 20 "
N. Charlestown..	293	157	450	182	475	210	500	25 " 50 "
S. Charlestown..	284	166	450	216	500	206	490	50 " 40 "
Bellows Falls....	283–34	191–142	425	203–252	486	207	480	61 " 55 "
Walpole.....	226	169	395	239	465	224	450	70 " 55 "
Putney.....	215	135	350	150	365	210	425	15 " 75 "
Brattleboro.....	200	141	341	290	490	210	410	149 " 69 "
Northfield, Mass.	177	128	305	213	390	213	390	85 both

This table shows us first, that the terraces slope downwards at about the same angle with the river's bed. A lake or ocean is therefore not necessary for their formation, and for similar reasons the tributary deltas may represent floods greater than that of the main stream. A study of the strata of the deltas shows that they slope rapidly as if deposited upon a considerable pitch towards the main stream. Secondly, the tops of the highest normal terraces do not slope continuously and uniformly according to the figures in the second and third columns. This would seem to indicate a variation in the magnitude of the flood or of obstructions. It is most marked between Thetford and Wells river, where the height is less than half that of the same terrace above and below. It is possible that the greater altitudes of the terraces below Thetford may have been occasioned by an inequality in the bottom of the

Digitized by Google

river. The kame gravel beginning at Thetford may have constituted an obstruction to the free flow of the river. The gradual rise northwards of the deltas in column seven does not agree with the inequalities of the same as stated in column five. Thirdly, the last column shows the differences in the height of the deltas and normal terraces given by both authors. If we are not required to accept the deltas as a measuring rod, we shall largely reduce the depth of the stream and thus learn why the velocity as calculated by Dana is far too great. If the value of a theory consists in its ability to explain phenomena, then certainly the view that the lateral normal terraces indicate the height of the glacial flood is to be preferred to that which would make the tributary deltas the index.

The other point of difference between these authors concerns the existence of a kame between Thetford and Windsor. The one describes an arched ridge of coarse gravel and sand following the lowest level of the valley and dipping beneath all the terraces. The other insists that this gravel is a series of beds capping the higher terraces.

The best locality to settle this question lies about a quarter of a mile from my residence. I have passed it hundreds of times, and always observe the relation of the two deposits in passing, and remark how the kame-gravel dips beneath the terrace loam. I have examined this and several other similar sections described by Professor Dana — as upon both sides of White river — and with this gentleman's printed paper in hand, so as not to misunderstand his views, and find that Mr. Upham's sections and descriptions are entirely correct.

Dana accounts for the presence of the very coarse gravel in the middle of the valley, by supposing it to have been brought down by tributaries. Thus the coarse gravels at White River Junction are thought to have been brought down White river and dropped where the tributary joined the Connecticut. If so, then the gravel should be composed of pebbles corresponding in character with the rocks in Vermont; but the most of them consist of material derived from the north. As the glacial current came from the northwest, these fragments of northerly origin could not be distributed much to the west of the Connecticut. Scarcely any are to be found west of the kame, thus proving the gravel to have been deposited by the Connecticut flood and not by the White

Digitized by Google

river. Furthermore, this tributary enters the main stream through a gorge-like channel pointing south of east. Its sediment could not be distributed to the north up and against the Connecticut current, but this gravel bed is continuous for *one-and-a-half miles up the Connecticut* above the mouth of White river. Hence it could not have been brought by the White river.

Accepting, therefore, the existing of a kame in the Connecticut, we have still further reasons for reducing the size of the glacial flood, and thus of harmonizing our theories with observed facts.

Mr. Upham's careful studies of the modified drift of the Merrimack and the other New Hampshire rivers do not indicate such differences between the normal and delta terraces as have been pointed out in the Connecticut. Calculations of the volume and velocities of the glacial Merrimack, Contoocook and Saco rivers would be based upon the altitudes of their highest normal lateral terraces.

Contribution to Seismology. By Richard Owen, of New Harmony, Indiana.

[ABSTRACT.]

The object of the paper is to point out the relation between solar and terrestrial dynamics, especially during the shorter secular changes: to show that when there is even a slight increase or diminution of motive power in the sun, there is, both as regards time and space, either directly or indirectly, a corresponding increase or diminution of the earth's kinetic energy, bearing on inorganic and also on organic matter.

DEFINITIONS, EXPLANATIONS AND ABBREVIATIONS.

The words force, power, energy are used as synonyms, denoting the inherent attribute of bodies, which gives rise to the various forms of motion, whether molecular or mass. The adjectives motive, kinetic, dynamic are also used as interchangeable, without essentially varying the meaning. "Seismic" is employed in

Digitized by Google

its most extended sense; embracing the phenomena of earthquakes, volcanic outbursts — whatever the material erupted — geysers, hot springs, gaseous emanations from solfataras and fissures, as well as land elevations and depressions. Great circles are abbreviated to G. C., and are considered as belts having a surface width about fifty miles each side of the theoretical line. The five equidistant G. C.'s described, in the Boston paper[1] for American Association for the Advancement of Science, as east continental trends, and which are secondaries to the ecliptic at our summer solstice, will be designated, beginning at Macassar's Straits, as A, B, C, D, E; while their mates, defining chiefly western trends, and being secondaries to the ecliptic at our winter solstice, will be called A′, B′, C′, D′, E′. The two terminators for noon and midnight at the meridian of land centre, described on p. 445 of said paper, are abbreviated as F and F′, while the meridian of Mount Rosa (land centre, in about 8° E. long.) may be called P. M., and its prime vertical, whose seismic importance will be shown, is designated as P. V.

In an abstract, necessarily, only a few illustrative examples can be given, thereby detracting much from the materials for a general deduction, and lessening the probability of its acceptance.

I. *Distribution in space of kinetic energy, whether molecular or mass-motive.*—Let us trace (best with charcoal) on any Mercator's map, which exhibits the volcanoes and earthquake regions, all the G. C.'s given in the above paper on "Land-forming," as well as the P. M. and P. V. To these add the concentric circles for each continent, as described in same paper, as well as for Mt. Rosa, the centre of the land hemisphere.

Additional, and not of least import, are the radial fissures (resulting probably from cooling and contraction) diverging from these land centres. The most important usually form with each other, angles[2] at the focal centre of $\frac{360°}{3} = 120°$; while others are $\frac{360°}{6} = 60°$, or sometimes even $\frac{360°}{12} = 30°$.

Having traced these enumerated circles and fissures, we shall find that we have now covered, with our charcoal belts, almost

[1] Boston Proc. A. A. A. S., pp. 437–446.

[2] The discussion of the above law being found too extensive, as at first designed, for a foot-note, and being considered to apply with equal force in plant development, is made the subject of a short, separate paper.

Digitized by Google

every portion marked in the maps as seismic, except Jan Mayen in the north, and Mt. Erebus in the south. Furthermore the paper shows that the G. C.'s follow the mountain ranges and the junctions between geological formations, besides several other points, in illustration of which a few examples are subjoined under their appropriate headings.

1. *These great circles accord with mountain ranges.*—Witness the Appalachians and western Ghauts parallel to D; the Rocky Mountains, Great Khingin and Stanovoi to F; the Sierra Nevada to D′; the mountains of Greece, Turkey in Europe, Bohemia, etc., to B′.

2. *These G. C.'s mark geological trends between two formations.* D passes along eruptive rocks, separating Palæozoic from later formations in the United States; B′ in Greece and Turkey runs between Cretaceous and Tertiary, in Bohemia between Palæozoic and newer rocks; then again going N. W. passes between Mesozoic and Cenozoic.

3. *The intersections of G. C.'s are highly seismic.*—Santorin is at the intersection of B′ and E′; Caracas at that of A and P. V.; Sumatra and Quito at the junction of three G. C.'s; Iceland of two; San Salvador of two; Lisbon of two; the extinct Eifel volcanoes of three, viz., P. M., B′ and C; Japan, at its V. Fusi-yama, of two; the Cutch, with its Ullah Bund, of two, viz., D and P. V.; the submarine Atlantic volcanic region of two, C and C′.

4. *They mark linear volcanoes, rising and sinking areas, also geysers, hot springs, etc.*—The volcanoes of Kamtchatka, the Kuriles, Japan, etc., are on A; and those of South and North America chiefly on F. The Greenland subsidence is on B′ and E; east end of Candia sinking is on B′; the west end on E′ is rising. The area in north of Scandinavia, now rising, is traversed by D, F′ and A′; the south portion, sinking, is crossed by C. The great subsidence in the Pacific seems mainly due to E and E′; also to C and C′; while lake depression of central North America[3] is due especially to A. The oscillations in Belgium,[4] as well as those in the Danish Island of Möen[5] are on belt C. The geysers of Iceland are found on D and B′; those of our "National Park" on B′; the fires of

[3] Dana's Man. of Geol., p. 391.
[4] Encyclop. Brit. (9th Edit.), Vol. III, p. 444.
[5] Lyell's Antiq., p. 393.

Digitized by Google

Baku are near P. V.; the gaseous emanations (now extinct) of Delphi and Livadia on B′; the dog-grotto carbonic di-oxide, near Naples, is on the fissure from Rosa, through Stromboli to Messina.

5. *They connect places of synchronous, earthquake tremblings.*—Quito and Ochotzk[6] are on F; Malta and Scotland on the direct fissure connecting those two places through Rosa; Milan and Tornea on fissure from Rosa to Baltic; Messina and Upsala connect at Rosa by two fissures forming an angle of 120°; yet perturbations at Berlin did not extend to Paris[7]. Scandinavia is connected with Iceland by D, but not with Great Britain.[8]

6. *The areas of these seismic belts seem favorable to metamorphosis and crystallization of rocks and minerals.*—In the Grecian Archipelago, along B′ and E′, the limestones appear to have been all converted into marble—it is so abundant that even the curb-stones at Athens are marble—and along D we observe similar effects in North Carolina, Virginia, Maryland, New York, and Vermont; and the radial line of force from Rosa, skirting between the west coast of Italy and the left flank of the Appenines, through erupted rocks, aided to give Carrara and other cities, near that line, their marble, they being on the radial belt from land centre to Calabria, Messina and Etna. The belt A passes through the diamond region of Brazil; E runs close to the African diamond district, while D is near the Golconda and Ceylon areas, noted for gems.

7. *The magnetic force exhibited in the earth's crust to the east of Kew and Lisbon*, north of Vienna and northwest of Petersburg, described[9] by Prof. Grylls Adams, is fully explained by following great circle C; also *Low Barometer*, possibly due to tension *prevailing sometimes along belts of G. C.'s, seems to predispose those areas to linear storms.* No. VII, of the Signal Office records,[10] followed the track of D; the hurricanes of our coast, originating near Florida, run parallel to D; and the typhoons of Japanese waters are parallel to F and A.

[6] Mallet's Cat. of Earthq., 5th Rept., pp. 55-6; also Plate X *bis*.
[7] Cosmos, Vol. IV, p. 143.
[8] Mallet's Cat. of Earthq., 4th Rept., p. 3.
[9] Lecture delivered at Royal Institution, June 3, 1881 (Nature).
[10] Houston's Phys. Geog., p. 140.

Digitized by Google

8. *At least three of the foci of magnetic intensity are at the junction of two G. C's.*—The sub-Australian focus is at the intersection of D with E; that of Siberia is near where B and E′ meet; that in the South Pacific is at the junction of A′ with E′.

9. *These belts traverse chiefly fertile tracts of land, and often pass through regions of extinct gigantic animals.*—The densest forests of South and North America are on A and D; while the giant Sequoias of California are on D′, not far from its junction with B′. The extensive forests of Bohemia, Thuringia, etc., are also on B′. Belt D′ covers the Patagonian area of Glyptodon, etc.; P. V. and E that of the New Zealand Dimornis, etc., A′ and C′ of the Australian Diprotodon and the like; A and D and B′ of the gigantic remains in the United States; B and E′ those of N. Siberia; F′ those of the sub-Himalayas.

10. *The chief civilization appears often to follow continental trends marked by G. C's.; and in Europe also the P. M.*—The civilization of eastern Asia is covered by A and F; that of Africa mainly by B and B′; in South America F marks the older civilization of the Incas, the Yucatan architecture, then passes near the Aztec, Toltec, and perhaps Arizonian developments; while the mound-builders spread along A, and later Anglo-Americans along D; latest on belt D′. In Europe the palæolithic, and neolithic evidences in Scandinavia and Denmark, the *find* at Neanderthal, the lake dwellings in Switzerland, and the remains in the caves of Engis, Mentone, etc., are all on or near the P. M.

11. *National and individual development seem greatest on some of these belts.*—Grecian and Macedonian history followed B′ into Austria and Germany; Rome spread her power along the fissure which traverses Sicily, Rome and Rosa (Helvetia), through Gaul to Britain; the civilization of Spain, France, Belgium, Holland, Prussia and Denmark is found on C; while F′ traverses Scandinavia and western Russia to near Gangetic Hindostan (Benares, etc.), as does the P. V., the Caucasus and Persia.

Should this law be found to prevail, as it has thus far, in numerous individualized applications, it would point to an additional important factor in the influences of environment; and when we find the belt of B′ passing through *eastern* Greece, the law may aid us to understand (especially in connection with the distribution

Digitized by Google

of kinetic energy in *time*) why the inhabitants of Attica were the ablest of the Greek sub-races, and why, between the years 530 and 430 B. C., Attica should have given to the world fourteen of the most illustrious men in history out of about 135,000 males, counting three generations to a century.[11]

II. DISTRIBUTION OF SEISMIC PHENOMENA AS REGARDS TIME.

The tabular synopsis, exhibited with the unabbreviated paper, shows that seismic phenomena group themselves around the sun-spot periods; for instance, Etna was quiescent from 1694 to 1755; the years 1698 and 1753 being two of the consecutive fifty-five year minimum periods. The synopsis further demonstrates that, by computations from Mallet's "Catalogue," earthquakes were much more numerous, relatively to the whole number for a given period, in middle Europe about the year 1663 (when there was no declination of the needle in middle Europe), than for the same number of years before and after 1814 (the period of greatest westing of the needle in middle Europe), apparently indicating that maximum seismic activity gradually follows the changes in the magnetic meridian of a continent.

The tabular view shows also that sun-spot periods coincide with meteorological anomalies (such as a severe winter followed or preceded by a hot summer). The geothermal changes, in middle latitudes, perhaps following the atmospheric maxima and minima after six months,[12] may, by differentiated heat (as when at the heated junction of the Bismuth-Copper Thermo-multiplier, the Bi., unable to transmit heat as rapidly as Cu., converts a portion into electricity), produce magnetic anomalies in those years of thermal anomaly, as indicated by the magnetic needle standing still, or even retrograding for a year or more, instead of pursuing its regular secular march.

Although the whole magnetic system is undergoing secular changes, the mean plane of oscillation seems to coincide with the meridian of land-centre, and to pass through the terrestrial equator between St. Thomas Island and the coast of Guinea. There

[11] Lyell's Antiquities, p. 547.
[12] Cosmos (Sabine's Trans.), Vol. IV, p. 38.

Digitized by Google

the equator of dip intersects the equator of rotation, and the equator of intensity crosses this same meridian of land-centre farther south about 10°–15°; both at present running somewhat parallel to our winter ecliptic, while in perhaps three hundred and thirty years (as estimated below) these equators will run nearly parallel to that of our summer solstice. Additional evidence of the land-centre meridian being also the mean central plane for the magnetic system is found in the fact that (on using this meridian as the dividing plane), the sum of the magnetic intensities in the eastern hemisphere is almost exactly equal to the sum of the intensities in the western;[13] also that the measurements from the region of least magnetic intensity south of St. Thomas to at least three of the foci of maximum intensity, as well as to Boothia Felix, are as nearly equal as are their relative intensities. Again the equator of dip near St. Thomas does not differ in position much from the mean equator of heat (mean isothermal of 80° F.) and the northern foci of greatest intensity do not vary far from being the poles of maximum cold in North America and Siberia. The close conformity of isocheimal lines to isoclinics is also pointed out, and some explanation is offered why in our Middle States and Alaska the declination E is diminishing, while in California and some adjoining regions it is increasing.

Eminent astronomical authority admits not only the above discussed variation in the sun's activity, but also its bearing on the earth, thus:[14] 1. "The equatorial regions of the sun have at least $\frac{1}{16}$ higher temperature than the portion beyond the thirtieth parallel of lat. 2. The temperature of the sun is a trifle higher in the northern than in the southern hemisphere. 3. The sun-spots emit less heat and light than the other regions." Another astronomer[15] says: "In 1637 sun-spots were so numerous that the heat and brilliancy of the sun were perceptibly diminished;" and again:[16] "Sun spot periods coincide . . . with variations of magnetic force and the periodicity of auroræ boreales. The periodicity of the spots indicates, as Father Secchi remarks, a periodicity in the solar activity . . communicated to the earth."

[13] Polyt. Review for Dec. 14, 1878, p. 247.
[14] Father Secchi on the sun, p. 133.
[15] Rambosson's Astronomy, p. 70.
[16] *Ibid*, p. 75.

Digitized by Google

Any gradual change in the sun's power, which would modify the thermo-electrical influence, might directly or indirectly produce the secular change in the needle from greatest easting to greatest westing and *vice versa*. As to the time in which this takes place, although we have not yet sufficient data for any certain calculations,[17] some coincidences seem to point to a period of about three hundred and thirty years, thus:

30 × 11,	the minor sun-spot period	= 330 years.
6 × 55,	" major " "	= 330 "
2 × 164,	twice the period of Neptune	= 328 "
4 × 84,	four times the period of Uranus	= 336 "

Possibly these combined influences may have some bearing in connection with other forces (perihelion, perigee, etc.) in effecting an electrical and magnetic predominance, thus, as remarked, producing greatest westing when the maximum force prevails in our winter solstice, and greatest easting when the most energy exists in our summer solstice.

By tentative calculation, taking the ratio of the secular period at Paris from 1663 to 1814 (the arc of variation from Boothia Felix to N. Siberia forming at St. Thomas Island an angle of about 23°–24°, and at Rosa fully double that arc, while at Paris it is greater, but unequal for easting and westing), the secular period of magnetic oscillation for middle Europe might be about as above, nearly . . = 330 years.

An evident relation is also traced and exhibited in the synopsis between those centuries marked by Mallet as seismic (first, fifth, ninth, twelfth, and eighteenth), showing them also to be historically of great importance; while, on the contrary, few stirring events occurred in those centuries recorded by Mallet as non-seismic, viz., the first and second B. C., as well as the third, seventh, tenth and fourteenth centuries of our era.

This suggestive thought is worthy of further investigation, in order to trace the influence of environment on anthropographic and ethnographic development.

[17] Report of 1881 by Chas. A. Schott, Esq., Assistant U. S. Coast Survey.

Digitized by Google

Law of Fracture, or Fissuring, applied to Inorganic and Organic Matter. By Richard Owen, of New Harmony, Indiana.

[ABSTRACT.]

As the unabbreviated paper applies the law to inorganic and also to organic bodies, this abstract commences with the former.

I. *Inorganic.* If pellets of clay, or other plastic spheroids, be dropped into a bowl, the lateral pressure compels them to assume, and present to the eye, an approximately hexagonal form.[1] This is the polygon of greatest sides, susceptible of lateral junction with similar polygons, so as to leave no intervening spaces. We find, on examining this junction of spheroidal bodies, compressed while plastic, that the lines of contact present, where any three of these polygons come together, three fissures or lines of fracture, diverging at angles of $\frac{2}{3}\frac{4}{6}^{0} = 120°$. If, however, these hexagonal fissures again break up into equilateral triangles, by the prolongation of these sutural chord fissures into the adjoining hexagons, then these six prolonged fissures meet at a central focus.

Further, if we break a pane of glass, or a cake of cap cement, by a smart blow of a sharp instrument, placed centrally on the pane or cake, we find that the radiating cracks or fissures, thereby produced, present angular fragments having, at the focal point a measure of 60° or 30° or occasionally of 120°. This law can also be traced in the cooling and shrinking of basalt: thus giving rise to a set of vertical fissures diverging 120°, as in the separation between the columns of the Giant's Causeway. The same tendency can be traced in mud when drying, although often sun and wind, acting chiefly in two directions, may give rise to right square prisms. Fissures resulting from an upward force have radial earth fractures, as after the earthquake in Calabria.[2] If the columns separate also horizontally, then we have such exhibitions as at Bertrich Baden Cheese Grotto.[3] Should the superincumbent layers be so distributed, as in bee cells, that the unit of an upper layer is directly over the triangular fracture between three contiguous units below, and in its turn be pressed upon by three units above, each such unit would in the upper layers be enclosed by nine rhombic planes, and in the intermediate layers would assume the dodecahedral form.

[1] Key to Geology of the Globe, p. 85.
[2] Lyell's Prin., II Vol. p. 124; also pp. 127 and 128.
[3] Lyell's Elem. (ed. 1856) p. 485.

Digitized by Google

In the separation, however, of contracting bodies, as well as in the compression of adjacent plastic spheroidal bodies, if some cells or units are smaller than others, or if the pressure is unequal, or the ingredients not homogeneous, the result may present a pentagonal cross-section. The hexagonal and radial system of fissuring has apparently nothing in common with the so-called joints, well described by Prof. G. K. Gilbert,[4] which are often at right angles to the planes of stratification, and parallel to each other; nor with slaty cleavage, probably due to such compression as forces all the planes of the fragments (*e. g.*, plates of mica in mica slate) into the same plane with the compressing force.

Although, on our globe, the five equidistant great circles of least resistance (or greater seismic force from interior) and their mates, in consequence of being secondaries to the ecliptic at the solstices, would point to solar influence as at least contributing to give them importance, yet the tendency of the solid materials in the earth's crust, particularly at continental centres, to separate by definite radial fractures, when acted on by erupting force from beneath, exerted at various geological periods, evidently follows the same law of fissuring stated above: the fissural lines being sometimes marked by a chain of lakes (as from the centre of North America running N. N. W.); or an extensive gulf (as that of Guinea or Genoa); or occasionally by interrupted elevations, islands and mountains, such as the line from the centre of Africa, near St. Thomas, running N. N. E. through Prince's Island, Fernando Po to the Cameroons and other mountains, as well as S. S. W. to St. Helena; or the 120° divergence in the Carpathians from the Tatra centre of Europe; or the Altai range running S. W. from the centre of Asia, while another range, diverging from it 120°, trends S. E. toward Lake Baikal. By bringing Mt. Rosa to the zenith, we can readily, on extending a string thence successively to every 30° around the globe, trace twelve radii, marking usually depressions, some radii more important than others because passing through highly seismic regions, thus:

1. Calling the meridian of Rosa which runs close to Corsica, Sardinia and Tunis, the Prime Meridian (although Greenwich Meridian is eight degrees W.), we have the termination in the re-entering angle at the Gulf of Guinea, the true centre of Africa. 2. Diverging thirty degrees E. we have a highly seismic belt

[4] Am. Jour. of Sc., July, 1882, p. 50.

Digitized by Google

from Rosa, covering Elba, Rome, Naples and Etna; broad enough to take in also Calabria and Malta, thence to lakes Albert and Victoria Nyanzi, and the west coast of Madagascar. 3. A seismic belt, marking the Adriatic and Santorin, passing between the Dead Sea and Mt. Sinai to Cape Gardafui. 4. The E. extension of the Prime Vertical, through the Black Sea, the S. shore of the Caspian, and the Demavend Volcano, to Cutch and the reëntering angle N. of Madras. 5. The line through Tatra, Europe's centre, to the base of the Urals. 6. Through the Baltic to the White Sea. 7. The N. end of our Prime Meridian running through Behring's Straits, etc. 8. A belt, through the E. coast of England and W. of Scotland to Iceland and Greenland thence through Hudson's Bay to Vancouver's reëntering angle. 9. A belt through Mt. Blanc to the Land's End, England, through the Bay of Fundy and along the Appalachians to the Gulf of Mexico and the Volcano of Colima. 10. The W. end of the Prime Vertical, along the Cantabrian Mountains, through the Azores to Caracas, Quito, etc. 11. A S. W. belt through Cape Vincent, probably between Madeira and Funchal to near the Canary Islands, and through Brazil in a line parallel to the mean trend of its mountain ranges, finally to the disturbed region of Valparaiso. 12. A S. S. W. belt through Minorca, Liberia and Ascension, to the Falkland Islands.

Pieces of pasteboard, cut with angles of 120°, 60° and 30° will be found convenient for measurements, when applied to globe, map or organism. The five great circles, which in the paper on land forming were shown to be 72° apart at the equator, form angles of 60° at their intersection near the polar circles, and enclose successively: 1, Asia; 2, Europe with Africa; 3, S. America; 4, N. America; 5, Oceanica and Australasia.

The above law of fracture seems also to apply to the confluence of rivers: primary tributaries usually forming, with the great continental drainage stream, angles of 60° (as the Missouri and Mississippi) or even 120° when belonging to separate drainage systems (as the Ohio and Mississippi rivers); while the secondary confluents anastomose sometimes at angles of 60° (as Wabash and Ohio); but occasionally at 30°; third-rate tributaries usually enter those of secondary importance at angles of about 30°, as White river at its junction with the Wabash, or Washita with Red River.

The paper next passes to an examination, how far the law applies to plants:

Digitized by Google

II. *Plants.* If the primordial cell, with its protoplasm and central or subcentral nucleus be in juxtaposition with similar cells, and somewhat crowded, each cell assumes a more or less hexagonal form;[5] and a unicellular plant, such as protococcus, offering an epitome of vegetable life, presents, when young, the division into six equal triangles, whose sides radiate to the central nucleus.[6] In all cellular tissue,[7] as well as in vascular tissue, we can trace more or less of the hexagonal cross-section, and even the tendency to radial fissuring. From this cause, apparently, in the verticillate forms of plant growth, such as that of the pines, we find sometimes three branches thrown out horizontally, each at an angle of 120° from the other, oftener six at equidistant angles of 60°. Whereas, in most of those plants having a spirally ascending growth, we find branches, or petioles, given off, whether opposite or alternate, at angles which form an aperture of 120° with the lower part of the trunk or rachis, and angles of 60° with the ascending stem, and which in the alder cycle (fourth leaf above first) diverge from each other at angles of 120°, when viewed in horizontal section. The axillary bud, whether leafy or floral, emerges from the stem at an angle of 30°. When the hexagonal type prevails, as in many monocotyledonous plants, it seems natural that at those six angles, where the least resistance is offered to dehiscence (the most pressure being near the centre of each hexagonal line of cell-junction) the greatest facility should occur for gemmation; the same applies to the pentagonal arrangement, so prevalent among exogens; also to the four-parted or cruciform type; from whatever cause these modifications may arise. The angular divergence indicated above can, by means of the pasteboard angles, be very readily measured in young timber or among the commonest flowers and weeds: the 30° growth probably predominating in excurrent trees, while the 60° branching is characteristic of the trees with solvent axis; and is found in the great majority of common plants. The divergence of secondary branches, at an angle of 60° from the primary, brings the former approximately parallel to the ascending axis, thus lessening the tendency to breakage of tree limbs, while presenting leaf surface well distributed to air and sunlight.

The coalescence of adjacent side walls of cellular tissue, running as medullary rays, from the central pith to the epidermal layer of

[5] Ency. Brit. (9th edit.) p. 73. [6] Ibid, p. 81. [7] Gray's Les. in Bot., p. 145.

Digitized by Google

the plant, gives rise, by the union of two triangles of cellulose-enclosing parenchyma, to a rhombus, which by lateral pressure and upward growth becomes very acute, and presents, in the bark, those diamond shaped areas found on hickory, black locust, and the like, while the bark markings on some trees of less rapid growth, approach, in their obtuse rhombic form, almost to squares. The crowding of each separate seed against its neighbors, in the large cone, borne by the Italian pine, exemplifies also the hexagonal system; and the tricarpellary dehiscence of the seed vessel in Köhlreuteria (a Maplewort) with its three midvein dissepiments, exhibits three equal compartments for the seeds, which in other pericarps, by duplication, may become hexamerous.

III. Animals. Among the Actiniæ,[8] we find the hexameral arrangement of primary mesenteries, after the normal type; their six fleshy septa extending from the outer edges of the column wall to the centre, while the secondary or intermediate mesenteries do not reach the centre. Among corals the disposition of the six primary septa, and additional forty-two intermediate septa, especially of the corals usually assigned to the order *Zoantharia sclerodermata*[9] (as well as the crowded corals in some specimens of the extinct *Cyathophyllum rugosum* is strikingly conformable to the hexagonal type, with strongest radii to points of least resistance. The gemmation among some of the Radiates, as when "the Hydroid Zoophytes develop, at a diverticular prolongation of the soft interior substance of the stem,"[10] a Medusa bud, closely resembles plant-budding; and the bud prolongation diverges at an angular aperture of either 60° or 30°.

Among Articulates the *Coronula diadema* is a symmetrical six-sided prism, divided into six triangles not quite equal. The same beautiful provision for strength and susceptibility of contraction and expansion can be traced in the scoriaceous integument of the trunk fish (*Lectophrys camelinus*); and even, although not with such perfect regularity, in the attenuated snout of the paddle fishes (Spatularia).

The law is wonderfully illustrated in spiral univalve shells; depressed spires, as those of Solarium, Patella, Natica and Pyrula, showing 120°; medium spires, as those of Strombus, Ranella and Struthiolaria, forming an angle of 60°; more elongated spires, like

[8] Ency. Brit., Vol. vi, p. 328. [9] Ibid, Vol. iv, p. 332.
[10] Carp. Prin. Comp. Phys., pp. 544-6.

Digitized by Google

those of Cerethium, Mitra, Terebra and Melania, diverging 30°. Even the nodes, on the spirally ascending whorls (showing greater power or facility of development where they occur) when we place the vertex of the 30° pasteboard angle at the spire-apex and extend the sides to the nodes, evidently form with the axis of the columella usually angles of 30°. In some large Pyrulas, however, on the outer whorl, we find at 30° only an almost obliterated nodule; but the 60° aperture reaches a prominent node.

Oken recognized the vertebral bone as the type of the skeleton: and in the neural arch, as well as the hæmal,[11] we find six bones, while the atlas and pelvis have an evident tendency to the hexagonal form; and in the enamel of the teeth is shown, in the beautifully regular columns with six sides, an arrangement giving great strength for resistance to crushing force. The cell, however differentiated (*e. g.*, in mucous membrane [12]), is still the type of all organisms, and retains more or less of the hexagonal form.

In the animal, as in the plant, the five-parted form, here chiefly designed for prehension and locomotion, often prevails. Thus among radiates, the crinoids partake largely, both in body and extremities, of the pentagonal type, although some of the Cystidea (as Marsupites, Cariocrinus, etc.) are symmetrically hexagonal, even in detail. Of the Mollusks, the highest Dibranchiates exhibit the five tentacles duplicated. Among Articulates, the true insects conform to the hexagonal; but the Decapod Crustaceans exhibit the twice, or bilateral, five-parted type. Vertebrates give us often, among teleost fishes, five finny appendages (two pectoral, two abdominal, one dorsal, and sometimes, however, also one anal, to form the sixth). The highest reptiles (Crocodiles and Alligators) have five toes; among birds, the spur of the Gallinaceæ, added to the four toes, may point to a rudimentary fifth; the highest orders of Mammals, the Carnivora, Monkeys, and Man himself, all conform to the five-parted type of *ultimate* extremities. Indeed, if we include the neck with its sometimes elongated jaws, and the tail often prehensile, as both belonging to the *proximate* appendages, then we have in them also those two prevailing types, 5 and 6.

Again, as in the confluence of rivers, the paper shows the anastomosing of arteries, veins, and even nerves, as very generally

[11] Owen on the Skeleton and Teeth, pp. 27 and 28.
[12] Carpenter's Prin. of Comp. Phys., p. 406.

Digitized by Google

according with the law of 60° aperture, for important branches, and 30° for those of secondary importance. Occasionally the angle is one of 120°, where the veins, etc., come together from nearly opposite directions.

SUMMARY.

The law that homogeneous *inorganic* matter often fissures at angles of 120° seems derived from the fact that, when plastic clay-balls, or other spheroidal masses are acted upon by equal force from all directions inward, they are compressed into hexagonal prisms: each contiguous three separated by angles of 120°; and from the additional fact that again, when homogeneous matter is compelled to separate, by disruptive force acting equally in all directions outward, it fissures into hexagonal prisms. By the reciprocal prolongation (into adjacent cells) of the three fissures described above, each hexagon is liable to be separated by fissures (or in some organisms by partitions) into six equal triangles. In the case of Basalt, any three hexagonal columns, resulting from disruption, would offer at their focal junction, apertures for subsequent outflows: thus adding new matter to the external earth's crust. Such fractures, from whatever cause, may occur at different periods of the earth's history, often giving rise to "faults" of hundreds and even thousands of feet;[13] and may then close either permanently or temporarily. This applies especially to the opening of cracks from below:[14] such as those in Iceland, caused by an earthquake,[15] and reported to be forty miles long. The five equidistant great circles, on our globe (described in another paper), supposed to be belts of least resistance, probably owe their origin, at least in part, to external forces, inasmuch as they are secondaries to the solstitial ecliptic; some are also terminators for important continents during the sun's meridian fervor.

Plants exhibit the same hexagonal tendency in their cells, etc.; and send out their buds at symmetrical apertures of medullary tissue in the stem or branch:[16] the constriction at each end or joint apparently giving greater activity to the side buds.

[13] Fisher's Phys. of Earth's Crust, p. 213.
[14] Ibid, Phys. of Earth's Crust, p. 201.
[15] Ibid, Phys. of Earth's Crust, p. 189.
[16] Carpenter's Comp. Phys., p. 519.

Digitized by Google

Among *Animals* instinct prescribes the hexagonal form to some insects for their nidus, because it gives most internal space, combined with greatest strength,[17] from least material; while externally every three adjoining cells (and so on throughout the whole structure) unite closely without loss of space. Some of the lower animals give off, from regular apertures as in plants, buds, also organs of prehension and locomotion, etc.; while among higher animals, such as the mammals, the various complicated endo-skeletons, and sometimes exo-skeletons, as in Glyptodon, present modifications in which the whole or a part appears to derive its origin from the typical hexagonal tissues, differentiated by the protoplasm.[18] The rhombic scales of Ganoid fishes, the polygonal plates of the carapace and plastron of the tortoise (*e. g.*, box turtle) as well as similar dermal integuments, often result from the coalescence of two adjoining triangular plates.

The least resistance of compressed polygonal units would seem naturally to be at the angular junctions, because, at each of the six chords, the material, originally comprised in areas enclosed by the two arcs of circles, is now compressed to form a double suture-line, while at the angles there is the entire uncompressed length of the radius: consequently along those six radii (or five, in a pentagon) which enclose somewhat equal triangles, there would seem to be the least resistance to any material emanating from the central focus: whether magma, through fissures; buds where medullary tissue reached the periphery, ripened seeds at the carpellary walls of a dehiscing seed vessel; or protoplasm through ruptured cells in the prolonged connective tissue.

[17] Rev. J. G. Wood's Homes without Hands, pp. 447 *et seq.*
[18] Lecture by Frances E. White, M. D., in Pop. Sc. Mon. for July, 1882, p. 366.

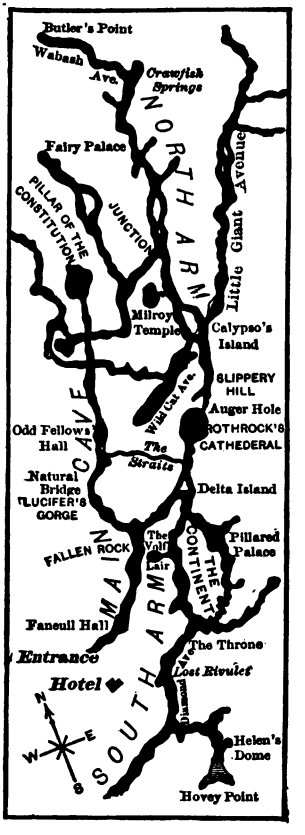
Digitized by Google

SUBTERRANEAN MAP-MAKING. By HORACE C. HOVEY, of New Haven, Conn.

[ABSTRACT.]

THE difficulties of subterranean map-making are peculiar. The task is very different from that of surveying a bit of meadow or prairie. Were it the more complicated one of mapping a region diversified by hills, lakes and rocky glens, yet there would be the advantage of doing the work by daylight. But an underground survey must be managed while creeping under low arches, following rugged and tortuous paths, skirting the edge of deep pits, fording miry pools, or climbing over rocky fragments piled under lofty domes. And all this diversified realm is wrapped in absolute darkness, but imperfectly scattered by lamps. Imagine a map of the Adirondacks made by torchlight on a series of moonless nights, and it will give some conception of the hindrances to a complete survey of such a place as Mammoth Cave.

MAP OF WYANDOT CAVE.



Add to this the fact that the singular barometric conditions make tests of altitude doubtful; and that the compass is often affected by magnetic disturbances. Consider, also, the natural reluctance of cave owners to have measurements taken that may show the limits of their surface rights to be less than their subterranean claim. No wonder that such a formidable array of obstacles should long have hindered the attainment of even approximately satisfactory results.

In exhibiting, therefore, maps that have been made of three of the most noted American caverns, namely, Mammoth, Wyandot and Luray, it should be understood that little more is claimed for

Digitized by Google

them than that they are helpful diagrams, and that they are the best results thus far secured from subterranean map-making in this country.

1. *Wyandot Cave*, in Crawford county, Indiana, was purchased by H. P. Rothrock from the U. S. government in 1820; but no attempt was made to survey its avenues till 1851, when the bearings and distances were taken by H. C. Grosvenor. Another survey was made in 1853, by D. L. Talbot, M. D. From these materials, supplemented by further explorations in 1854, I prepared the first complete map of this cave, the original draught of which is still in my possession. Mr. G. I. Langsdale afterward laid down some later discoveries; and the map, thus jointly constructed, was published, in 1860, in Owen's "Geological Reconnoissance of Indiana." My work was carefully revised by myself, in 1878, and published. About the same time Prof. J. Collet made a new map, from notes of his own, which appeared in the Rep. Geol. Sur. Ind., 1878. While differing from each other in minor points, the main features of these two maps agree, thus proving their general accuracy.

2. *Mammoth Cave*, discovered in 1809, is located in Edmondson county, in Kentucky, 85 miles S. S. W. of Louisville. It has been repeatedly mapped, but with remarkable variations. The first rude outline was prepared in 1814, probably by Mr. Gratz, the early owner of this cave, and published in the Med. Repository, vol. xvii, p. 391. It abounds in inaccuracies. A careful survey was made of the portion then known, in the winter of 1834–5, by Edmund F. Lee, C. E., who devoted three months to the task. His map, published by James and Gazley, of Cincinnati, O., is out of print and I have never seen any one who has examined a copy. Next came a map made from notes supplied by Stephen Bishop, the guide, and published by Morton and Griswold, of Louisville, Ky., along with a manual entitled "Rambles in Mammoth Cave." This, too, is out of print, the only copy extant being in my possession. It is said that the plate from which it was printed is destroyed. Dr. C. R. Blackall, of Philadelphia, made a map at a subsequent date, which, however, he was not permitted to publish, being restrained by an injunction. Another, but less accurate, map was prepared to go with Forwood's "Historical and Descriptive Narrative of Mammoth Cave." (Lippincott, 1870).

In the new map, prepared under my supervision, and completed

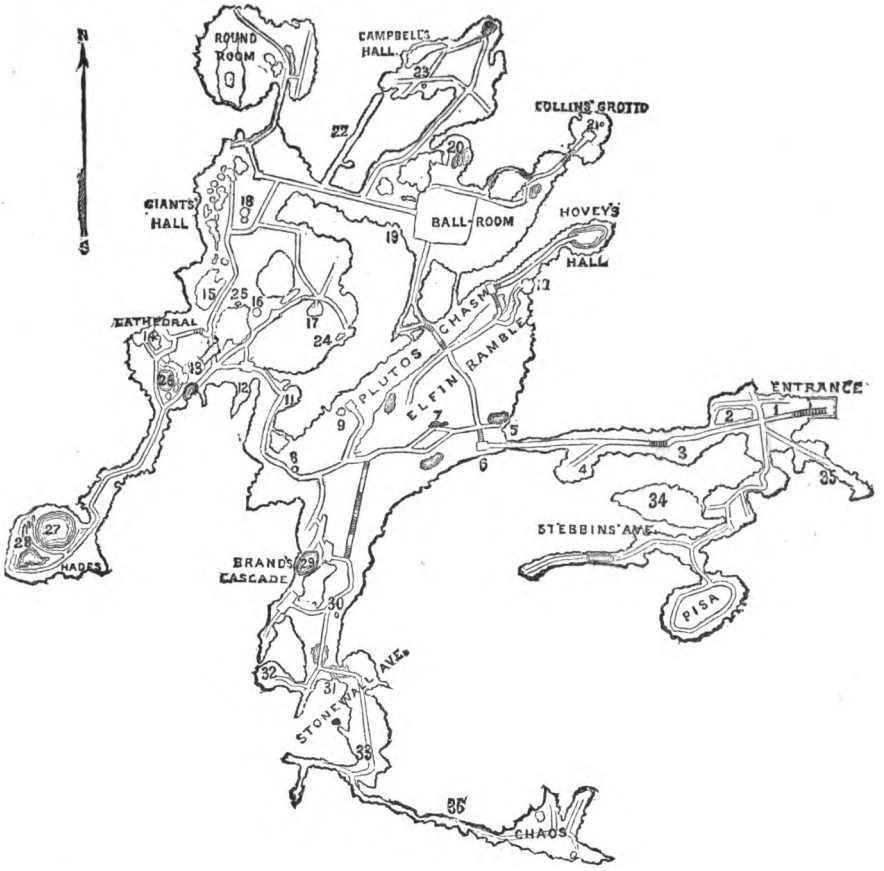
Digitized by Google

this year (1882), all the portion open to the public, as far in as the Echo river, is drawn after the recent survey made by Col. Francis Klett, manager of the cave, who had the advantage of previous experience in connection with the U. S. Geographical Survey. The portion beyond Echo river was drawn from a general survey of courses, the details being filled from older surveys, corrected by my repeated observations. I have not attempted to indicate more than 50 or 60 of the 223 avenues that are said to have been explored. The work is confessedly incomplete; but, such as it is, it comes nearer the truth than anything previously issued. The different levels are indicated by shading, the lighter shades denoting the higher galleries, and the darker marking the lower tiers and the pits and domes. The relative width of enlargements is only suggested as an aid to the imagination; the average being about 60 feet, and the greatest width not exceeding 400 feet. The vertical distance between the surface and the drainage level is about 328 feet. The general plan of the cavern is that of a vast labyrinth, with galleries crossing each other at various levels, the aggregate length of which is supposed to be 150 miles.

3. *Luray Cavern*, in Page county, Virginia, was discovered in 1878 by Mr. A. J. Campbell, and shortly afterwards was hastily mapped by Mr. A. Y. Lee, for the N. Y. Herald. Another map was made in 1880 by Mr. S. Z. Ammen. These were taken under the disadvantage of having to work by candle-light. This cave is now lighted by electric lamps throughout its entire extent, and by this aid a new survey was made this year for my use, with the endorsement from the manager, Mr. R. R. Corson, that "this is the only correct map of Luray Cavern ever made." The great room including the Elfin Ramble and Pluto's Chasm is about 500 feet long and 200 feet wide. Other large halls, *e. g.*, the Cathedral, and the Giants' Hall, are so filled with stalagmitic pillars as to prevent the visitor's getting a true conception of their vastness. Winding in and out among these mazes of stone forest and jungles, one is liable to magnify distances. The areal diameter of Luray Cavern does not exceed 2,000 feet, but the visitor usually imagines himself to have gone several miles under ground. The place has been aptly compared to the Centennial Buildings, when in their full glory at Philadelphia, amid whose embellished halls the visitor could ramble for days without satiety; and from which, on growing weary, he could at any moment withdraw, hoping to come again.

Digitized by Google

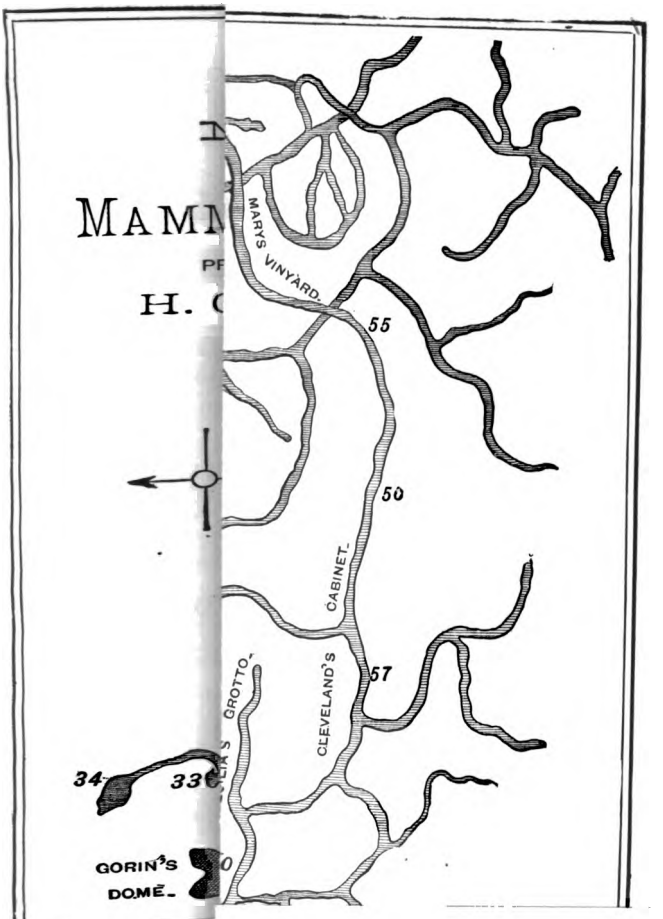
MAP OF LURAY CAVERN.



1. The Vestibule.—2. Washington's Pillar.—3. The Flower Garden.—4. The Amphitheater.—5. Natural Bridge over Muddy Lake. 6. The Fish Market.—7. The Crystal Spring.—8. Proserpine's Pillar. 9. The Spectral Column.—10. Hovey's Balcony and Scarfs.—11. Oberon's Grotto. 12. Titania's Vail. 13. Saracen's Tent, and Fallen Column.—14. The Organ and Throne.—15. The Tower of Babel.—16. The Empress Column.—17. The Hollow Column.—18. Henry Baird (or Double) Column.—19. Chalcedony Cascade.—20. The Coral Spring.—21. The Dragon of Luray.—22. Bootjack Alley.—23. The Mermaid, or Scaly Column.—24. The Lost Blanket.—25. Helen's Scarf.—26. Chapman's Lake.—27. Broaddus Lake.—28. The Castles on the Rhine.—29. The Imperial Spring.—30. The Skeleton.—31. The Twin Lakes.—32. The Engine Room.—33. Miller's Room.—34. Hawes' Cabinet.—35. Specimen Avenue.—36. Proposed Exit Avenue.

NOTE. In connection with the above paper, maps were exhibited by the author, showing the results accomplished in surveying Mammoth, Wyandot and Luray caverns, copies of which are here reproduced. At the evening reception given by President Dawson at the Redpath Museum, Mr. Hovey gave illustrations of cave scenery, by means of a lantern, from recent photographs taken by means of electric light.

Digitized by Google



Digitized by Google

rei
rej
ga
ele

Digitized by Google

Deep-sea Soundings and Temperatures in the Gulf Stream off the Atlantic Coast, taken under the direction of the U. S. Coast and Geodetic Survey. By J. R. Bartlett,[1] of Lonsdale, R. I.

[ABSTRACT.]

I have come to this meeting of the Association at the kind request of Mr. Hilgard, the Superintendent of the Coast and Geodetic Survey, to tell you of the investigations made by the steamer "Blake."

The hydrographic party of which I have charge has been investigating the Gulf Stream for the past four years, the last two summers having been passed on our immediate coast. All of you have ideas or pet theories in regard to this great river of the ocean, as Maury has happily called it. Many of our greatest scientists have written learnedly about it. Professor Bache, while he was Superintendent of the Coast Survey, caused extensive and systematic investigations to be made of its physical features. From the data obtained, the Stream was assumed to start from the Caribbean sea, making the circuit of the gulf of Mexico, and to issue with great velocity and high temperature from the straits of Florida, continuing to about latitude 45°N. It was described as a superficial stratum of warm water flowing over one of cold, with banks of cold water, and divided or bifurcated into warm and cold bands.

The bifurcation was explained by the presence of hills and valleys which were developed by the soundings, the cold water being said to be in the valleys and the warm water on the elevations. As no soundings were obtained in the strength of the current, it was supposed that the stream ran over, if not in, a great trough or depression of the sea-bed. At the time the investigations were made under the direction of Professor Bache, the means of obtaining the depth of the sea were very imperfect; now we have the most improved apparatus and soundings can be taken with wire in any current and to any depth with almost perfect accuracy.

The investigations made on board the "Blake" show conclusively that the above assumptions are wholly erroneous. My

[1] Commander U. S. Navy.

Digitized by Google

soundings give no channel for the Stream to run in, there are no hills or valleys, and I have never found any bifurcation or warm and cold bands. The temperatures obtained do not show cold water beneath the Stream, but a current of warm water between the Florida straits and cape Hatteras down to the very bottom.

As has already been stated to this Association by Mr. Hilgard, the current entering the gulf of Mexico from the Caribbean sea does not make the circuit of the gulf as formerly supposed, but passes to the northward and eastward in the same general trend as the Yucatan plateau, and thence to the straits of Florida.

The lines of soundings taken by the "Blake" were twelve in number, beginning at Jupiter inlet, Florida, and extending to Currituck, N. C. They were run normal to the general coast line.

The soundings give very interesting data in regard to the physical features of the bottom of the ocean over which the Gulf Stream flows. Instead of a deep channel in the course of the Stream, as reported by Lieutenants Maffitt and Craven, and published in the Coast Survey Reports, our later soundings with *wire* show an extensive and nearly level plateau extending from a point to the eastward of the Little Bahama banks to cape Hatteras. Off cape Canaveral this plateau is nearly 200 miles wide, and gradually contracts in width to the northward until reaching Hatteras, where the depth is more than 1,000 fathoms within 30 miles of shore. The plateau has a general depth of 400 fathoms, suddenly dropping off on its eastern edge to over 2,000 fathoms.

The course of the Gulf Stream can be traced by a study of the specimens of the bottom obtained; on each side of the Stream the sounding cylinder brought up ooze, but in the strength of the current the bottom was washed as bare of ooze and all living things as the bed of a mountain torrent. Instead of a cushion of cold water at the bottom, the temperatures were the same as those found at the corresponding depth of 400 fathoms in the Windward passage and in the course of the current through the Caribbean sea and gulf of Mexico.

The temperature of the surface-water was taken every mile on all lines and in no case were there found any warm or cold bands. There was a slight rise of temperature on entering the current, at the surface, and also a corresponding rise at the bottom in the

Digitized by Google

same locality. The surface temperatures found in the Stream were much below those generally given in published works on the subject. The average temperature in the axis of the Stream rarely exceeded 83°F. in June and July. On one or two occasions the thermometer read as high as 86°, and once 89°, but it was at high noon in a dead calm. The temperature at five fathoms did not range above the average of 81½°. The surface temperatures did not indicate a cold wall inside of the Stream; the water between the one hundred fathom-line and the shore seemed to be an overflow of the Stream, as the temperatures at five, ten and fifteen fathoms were nearly as high as those found in the Stream.

Lines for series of temperatures from the surface to the bottom were run during the past summer from Block island to the Bermudas, and thence to Hatteras. The isothermals show the Labrador current until nearing the Stream, when they descend gradually and in the stream itself abruptly, to their greatest depths. Instead of the warm stream-water thinning away as it was reported to do when spread out, it was not much over fifty miles in width at the time of our crossing, as shown by the current and high surface temperatures. The temperatures below the surface were much higher than at the same depths off the coast.

The ordinary temperature at the bottom off Savannah and Charleston in 400 fathoms was 45°. In the Stream between Block island and the Bermudas it was as high as 55° at 400 fathoms. The isothermals remained at almost the same depth to the southward, as in the Stream, on the entire line to the Bermudas. Just north of the Stream the temperature at 400 fathoms was 39½° and 40°. At a point well in the Labrador current away from the Stream, the temperature at 400 fathoms was 38½°.

From the Bermudas to Hatteras the isothermals were at the same depths as were found south of the Stream on the previous line, but when in the current off Hatteras, where the Stream trends to the eastward, they rose to the same depth as off Charleston and Savannah on the plateau.

These temperatures below the surface seem to suggest that the Labrador current underruns the Stream at Hatteras, but at no other point. It probably keeps its natural boundary or western wall along the 1,000 fathom curve, and thus follows around the plateau towards the equator. No definite conclusion can be drawn

Digitized by Google

from the data obtained thus far; but we have at least a clear field to work upon in the future, in regard to temperatures and currents, and the contour of the bottom as far as Hatteras is well portrayed.

Tables are appended giving the depths, etc., found on the several lines.

PREGLACIAL CHANNEL OF EAGLE RIVER, MICHIGAN. By CHAS. WHITTLESEY, of Cleveland, Ohio.

[ABSTRACT.]

IT is to little purpose that an abstract of this paper is given without the illustrations. Before the glacial era, the Eagle River, at the Phenix Mine, on Keweenaw Point, ran on the back of a vein carrying native copper, which bears about north 20° west. The depth of the channel was forty to sixty feet, very straight, and as it wore away the vein matter, masses of copper were left at the bottom, the largest weighing nearly a ton. On Point Keweenaw the drift striæ are about north 50° east, nearly at right angles to the old channel, and as the ice covering moved southwesterly it pressed the gravel, sand and hard pan into the channel, with great force. It was not only filled, but covered, to the depth of thirty to ninety feet, with the material of the moraines.

By mere accident Mr. Martin Coryell, M. E., who was in 1845-6 superintending the mine, while driving an exploring adit in the rock from the bottom of a shaft, struck the ancient channel, the vein, and the copper boulders. The water of the present channel was running on the gravel thirty to forty feet overhead. About 200 feet northerly, the present river makes a right angle to the west at the foot of a high drift ridge which crosses its course. Mr. Coryell followed the ancient channel straightforward under the ridge which must have joined the present channel between the mine and Lake Superior. He left such plans of the underground work, that in 1854 I was able to construct a map of the two rivers which was presented to the section. Evidently there had been little loose surface material in the preglacial ages.

Digitized by Google

Digitized by Google

Digitized by Google

Recent Discoveries of Fossil Fishes in the Devonian Rocks of Canada. By J. F. Whiteaves, of Ottawa, Canada.[1]

[abstract.]

Deposits containing remains of fishes remarkably like those of the Old Red Sandstone of Scotland and Russia were discovered by Mr. R. W. Ells, M. A., of the Geological Survey of Canada, in 1879, at Scaumenac Bay, on the north shore of the Restigouche River and almost immediately opposite Dalhousie. Mr. A. H. Foord, of the same Survey, has since devoted the whole of the summer seasons of 1880 and 1881, as well as part of the present summer to a systematic exploration of these fish-bearing beds, from which he has succeeded in obtaining a large and instructive series of specimens. Prior to 1879 all the rocks at Scaumenac Bay were regarded as belonging to the Bonaventure division of the Lower Carboniferous, but the fossils recently collected show that at this locality the conglomerates and red sandstones of the Bonaventure series are underlaid by shales and sandstones of Devonian, and most probably of Upper Devonian age. The genera and species of fishes collected from these shales and sandstones may be thus briefly indicated.

1. *Pterichthys Canadensis.* Extremely abundant and first described under the above name in the American Journal of Science for August, 1880. It may possibly prove to be identical with the *Bothriolepis ornata* of Eichwald, from Scotland and Russia, but that species, of which only one or two isolated plates have been found, has never been defined with sufficient accuracy to be recognizable. The Canadian specimens show most conclusively that there is no essential difference between *Bothriolepis* and *Pterichthys*, a fact to which Dr. Pander had called attention in 1857. The divergent, slightly curved barbels on the front margin of the head, which are indicated in Agassiz's restoration of *Pterichthys*, but whose existence was doubted by Pander, are well seen in one of the Scaumenac Bay specimens. The singular flattened-conical dermal appendages of the helmet, one on each side of the orbit, and represented in Pander's more recent restoration of the genus, are equally well exhibited in two other specimens from the same locality.

[1] Palæontologist to the Geological Survey of Canada.

Digitized by Google

2. *Diplacanthus*. An apparently undescribed species, remarkable for the small size of each of its fin-spines in proportion to the general dimensions of the body.

3. *Acanthodes Mitchelli?* Egerton. A few examples of a diminutive Acanthodean, which seems to be barely distinguishable from the Scotch species named above. The entire length of the largest individual is not more than one inch and three-quarters.

4. *Phaneropleuron curtum*. A shorter and deeper form by far than the only previously known species of the genus, *P. Andersoni* of Huxley, from Dura Den. Dr. Gunther has shown that of all the Devonian fishes *Phaneropleuron* comes nearest to the living *Ceratodus Forsteri*, of Queensland, both in its internal and external characters, though the dentition of *Phaneropleuron* was very imperfectly ascertained. Last summer Mr. Foord was fortunate enough to obtain specimens of *P. curtum* at Scaumenac with the cutting and crushing teeth well preserved. The maxillary teeth are short, curved-conical, smooth and somewhat compressed. The palatal teeth, like those of *Dipterus*, as figured by Hugh Miller in the "Footprints of the Creator," are triangular in outline and bear parallel rows of short, erect, conical denticles, thus making the affinities of *Phaneropleuron* with the living *Ceratodus*, and to the Dipnoi generally, still more apparent.

5. *Eusthenopteron Foordi*. Many large fragments of a fish, which when perfect must have been more than three feet in length, and which appears to be the type of a new generic form allied to the *Tristichopterus* of Sir Philip Egerton, from which it differs only in the following respects. In *Tristichopterus* the vertebral centres are ossified, the osselets of the lower lobe of the tail spring from 8 or 9 interspinous bones, and the teeth (according to Dr. Traquair) are conical and circular in section. But in *Eusthenopteron* the vertebral centres are not ossified, the caudal osselets of the lower lobe of the tail are articulated to the dilated extremities of the hæmal spines, and the teeth are compressed conical with sharp lateral cutting edges. The entire jaw of *Eusthenopteron*, in fact, is singularly like that of the so-called *Asterolepis* of Hugh Miller, as represented in the "Footprints."

6. *Glyptolepis*. A single specimen, not very well preserved, of a small scaled species, which is very similar to and possibly identical with the *G. microlepidotus* of Agassiz.

Digitized by Google

7. *Glyptolepis.* A second species appears to be indicated in the collection by large, isolated scales fully one inch in length, belonging to a fish more of the type of the *G. leptopterus* of Agassiz.

8. *Cheirolepis Canadensis.* A fine large *Cheirolepis* nearly related to the *C. Cummingiæ* of Agassiz from the Old Red Sandstone of Scotland, of which it may prove to be only a variety. The sculpture of the scales on the body and fins, and the general outline, are alike in both, but in the Canadian species the position of the fins is different to that of those of its European representative.

On the south bank of the Restigouche, about half a mile above Campbellton, another series of fish-bearing deposits was discovered by Mr. Ells in 1881. These also have been carefully explored by Mr. Foord, and a description of the species contained in them has since been published in the "Canadian Naturalist." At this locality the fish remains occur in brecciated limestones of about the age of the Oriskany and Gaspé sandstones, and much disturbed by trappean outbursts and overflows. The specimens, though often well preserved, are generally fragmentary, and the species so far recognized are as follows:

1. *Coccosteus Acadicus.* Cranial shields and detached post-dorsomedian, ventromedian and preventrolateral plates of a species of *Coccosteus* in which the ornamentation of the head shield is like that of *C. decipiens*, and the shape of the post-dorsomedian plate is the same as that of *C. cuspidatus.*

2. *Cephalaspis Campbelltonensis.* Large head-shields of a *Cephalaspis* of the subgenus *Eucephalaspis*, which show the orbits and the prominences and depressions in their vicinity very clearly. In all the other species of the genus the sculpture of the exterior consists of minute raised tubercles, but in this one the enamel is very finely punctate.

3. *Ctenacanthus latispinosus.* Fin-spines only, characterized principally by their regularly nodose, radiating ribs.

4. *Homacanthus* (species undetermined). Fin-spines, also, of a species of *Homacanthus* which seem to differ from the *H. arcuatus* of Agassiz only in size, the Campbellton specimens being much larger than the European ones.

At Scaumenac the only other fossils found associated with fishes are land plants, which latter have been described by Principal Daw-

Digitized by Google

son. The plants as well as the fishes found in the Campbellton breccias are entirely different from those at Scaumenac, and at Campbellton, entomostraca, *Spirorbis Erianus*, fragments of a large *Pterygotus* and two new species of *Cyclora* occur with the fishes.

The paper was illustrated by numerous specimens and by diagrams prepared by Mr. Albert Grignard, late draughtsman to the Canadian Survey.

NOTE ON THE OCCURRENCE OF SIPHONOTRETA SCOTICA (DAVIDSON) IN THE UTICA FORMATION NEAR OTTAWA, ONT. By J. F. WHITEAVES, of Ottawa, Ont.

[ABSTRACT.]

IN the spring of 1881 three single valves of a brachiopodous shell, whose margins are densely fringed with a single row of fine hairlike spines, were collected by Mr. J. W. H. Watts, R. C. A., from a band of impure limestone in the Utica Slate of Cumming's Bridge, near Ottawa City. These specimens have since been presented by Mr. Watts to the Museum of the Geological Survey of Canada. Upon examination with an ordinary simple lens it was at once apparent that they were referable to De Verneuil's genus *Siphonotreta*, and that in most respects they bore a very close resemblance to an English species, the *S. Anglica* of Prof. Morris. But the spines of *S. Anglica* are distinctly stated to be annulated, whereas in the Canadian specimens, as viewed under an achromatic microscope with an inch and a half objective, the spines appeared, to the writer at least, to be quite smooth.

Having occasion to send some Canadian brachiopoda to Mr. Thomas Davidson, F. R. S., a few months ago, for examination and comparison with British species, the three examples of the Ottawa *Siphonotreta* were forwarded to him at the same time, and in a letter received from Mr. Davidson in May last they are reported upon as follows:

Digitized by Google

"The *Siphonotreta* from near Ottawa interests me much. It is identical in shape and characters with the Upper Llandeilo species which I named *Siphonotreta Scotica*. I am very uncertain whether the Wenlock Shale species named *S. Anglica* by Morris is the same or not. Only one crushed specimen of the *S. Anglica* has been found and its spines are annulated as described by Morris. I could see no annulations in the spines of many specimens of *S. Scotica* found by Mrs. Gray in the Upper Llandeilo of Craighead, Ayrshire, nor do I see any in your specimens. As there is uncertainty as to the specific identity of the highest Upper Silurian form with the Lower Silurian one, and as none have been found in all that mass of intervening strata, I prefer provisionally to retain the two names, or until other Upper Silurian species shall have been found."

The interest of Mr. Watts' discovery lies of course in the fact that this is the first time that a species of the genus has been recorded as occurring in N. America.

On a Post-Tertiary Deposit containing Impressions of Leaves, in Cumberland county, New Jersey. By N. L. Britton, of New York, N. Y.[1]

[ABSTRACT.]

The deposit which this paper is intended to describe has long been known to a few geologists, but no detailed description of it has as yet been given. It is located near the city of Bridgeton, Cumberland county, N. J., near the shore of a large pond from which a stream flows and empties into the Cohansey Creek.

The material which bears the leaf-impressions is a rather coarse quartz sand, cemented together by hydrated sesquioxide of iron into a soft, friable sandstone. The stratum containing them is found immediately at the surface of the ground, apparently extending into the side of a low hill; it is at least four feet in

[1] Of Columbia College and assistant in the Geological Survey of New Jersey.

Digitized by Google

thickness, and in portions of it the impressions are very abundant, while at other points only an occasional one is to be found. The outcrop of this leaf bed may be traced for some twenty-five feet along the hillside. Its inclination is very nearly horizontal. This sandstone belongs geologically to the superficial formation which covers the Tertiary and Cretaceous strata of New Jersey, and also extends northward to some extent, as far as the terminal glacial moraine on the red shales and sandstones of the Trias. The materials composing this superficial formation are gravel, sand and loam, uniformly of a light color, generally yellow, white or gray, and from this circumstance it is known as the yellow drift; it is also termed the Pre-glacial drift, because it is older than the drift deposits due to glacial action.[2] This yellow drift is generally plainly stratified; it varies from forty feet or even more to a fraction of an inch in thickness, being sometimes represented only by a few yellow pebbles; it varies in coarseness from gravel with pebbles some inches in diameter to a fine sand or loam. It is often found that this material is cemented together into a reddish-brown sandstone or conglomerate by hydrated oxide of iron precipitated from springs since its deposition. This rock forms the only building stone native to the region and it is extensively used for lining wells, cellar walls, etc. A few buildings have been constructed of it, as the large seminary at Bridgeton. Casts of marine mollusks have been found in it at Tuckahoe, Atlantic county, where it contains casts of what were apparently the shells of the common hard clam (*Venus mercenaria*) and others, and I have recently secured specimens of other mollusks, mostly too poorly preserved for identification, in the yellow drift near Marlboro, Monmouth county. It also contains silicified fossil wood at Bridgeton, Shark River, New Egypt, Mullica Hill, and other localities.

The stratum bearing the leaf-impressions at Bridgeton is a rather coarse, soft sandstone — so coarse indeed that the margins of the leaves are often very indistinctly preserved making it difficult to determine the outline. The primary venation, however, and sometimes the finer subdivisions of the veins are easily to be seen.

The identification of the species represented is not yet completed. Among the genera we have *Liquidambar*, the sweet gum represented by several specimens of leaves resembling those of the

[2] For a full account of the Pre-glacial drift, see Annual Report of the State Geologist for 1890, pp. 87–97.

Digitized by Google

living species (*L. styraciflua* L.) but only three-lobed, instead of five- or seven-lobed as the leaves of that tree are; numerous specimens of a species of *Viburnum*, as shown by the venation; fragments of a broad-leaved grass, perhaps *Zizania;* serrated leaves of a species of *Ulmus*, and several other genera.

This is the only locality known in New Jersey where the preglacial drift contains leaf-impressions. The species will be figured and described in reports on the fossil floras of New Jersey, now in preparation.

TERRACES AND BEACHES ABOUT LAKE ONTARIO. By J. W. SPENCER, of Columbia, Missouri.

[ABSTRACT.[1]]

IN and about the Dundas valley, at the extreme western end of Lake Ontario,— topographically described by the author in his paper on the Origin of the Lakes, in the Proceedings of this Society for 1881,— there are the remains of a considerable number of terraces and beaches.

The lowest of these beaches is that forming the modern western shore of the lake. Burlington beach, which separates Burlington bay (a body of water about fifteen miles area and seventy-eight feet deep) from Lake Ontario, rises only eight feet above the water. It is composed wholly of sand and gravel (containing an abundance of fossils belonging to the Hudson river formation) which have been transported by ice and wave action, a distance of at least twenty or thirty miles, from a region northwest of the lake, along with a few crystalline pebbles. This beach and shore line contains no Niagara pebbles, although almost beneath the Niagara escarpment.

In elevation, the next terrace is south of the Dundas marsh, at

[1] For the minute details of the subject of this paper, the reader is referred to the author's lengthy paper on the "Surface Geology of the Region about the Western End of Lake Ontario," in the Canadian Naturalist for 1882, copies of which can be obtained from Dr. Spencer. See also American Journal of Science for Dec., 1882.

Digitized by Google

from 70 to 80 feet above the lake, and forms a plane of considerable area, made up of fine, thinly bedded, arenaceous clay.

The third and most conspicuous terrace is that at 116 feet above the lake and extends as a contour line, for long distances about the western end of the lake. It forms "Burlington height" which separates what is now the large Dundas marsh (at the level of the lake) from the lake. It is composed of the same material as the present lake shore—Hudson river sands and pebbles, without any admixture of Niagara pebbles.

Again in the Dundas valley we have isolated remains of former stratified shore lines at 180, 224, 261, 335, 440 (?), and 500 feet above the lake. All of these higher beaches are composed of sand and pebbles of the Hudson river period, with less or more *débris* of the adjacent Niagara formation. In fact, the study of the beaches about the western end of Lake Ontario shows a gradual recession of the water of the lake, with few sudden changes of level. Also the transportation of the greater proportion of the material of all the beaches was from the country northwest of the lake, and from lower elevations than those of the old shore line.

Between Toronto and Lake Simcoe, Mr. Thos. Roy measured beaches at 110, 210, 282, 310, 346, 402, 422, 502, 558, 626, 682, 734, and 764 feet respectively above Lake Ontario. In addition to these gravel beaches, others, at 600 feet, and on descending towards Georgian bay (along the Northern Railway) at 520, 388, and 354 feet, have been measured.

Along the Toronto, Grey and Bruce Railway, which extends in a direction north of westward from Toronto to and across the highest portions of the peninsula of Ontario, underlaid in part by the "Artemesia gravel" ridges, there are a number of conspicuous sand and gravel beds, which follow contour lines more or less closely. Edmund Wragg, Esq., furnished me with the following railway levels of many of these beds. They have been measured at 160, 280, 370, 710, 990, 1,120, and 1,340 feet above Lake Ontario. After crossing the summit of the road at 1,462 feet, there are extensive gravel beds at 1310, and from 1000 to 697 feet above the same datum along the main line of the railway, and along the western branch of the road, at 1299, 1130, 1050, 870, 850, and 830 feet above Lake Ontario. Near Owen Sound there are others at 546, 496, and 466 feet above Lake Ontario.

Digitized by Google

Along the Great Western Railway, in the valley of St. Davids, the interglacial outlet of the Niagara river is filled with stratified sand and gravel of the Hudson river formation from about 250 feet to 380 feet above the lake.

The elevations of terraces in New York State are imperfectly known to me. Eastward of Lockport there are the lake ridges from 158 to 190 feet above the lake (Hall). In the region of Seneca lake and Skaneateles lake, I have observed beaches of various heights to about 625 feet above Lake Ontario. In Michigan, there are beaches to 1350 feet above Lake Ontario (Rominger). Near Petit Écrit, Lake Superior, there are beaches at 398, 408, 458, 592, 627, 635, and 699 above the same datum (Geol. of Canada). Again, southwest of Lake Erie, there are beaches or ridges at 65, 90, 165, 195, 220, 350, 408, 386–490 feet above Lake Erie (Messrs. Gilbert and Winchell).

In the Ontario peninsula, the outline of the Artemesia gravel may be approximately represented by the 1250 foot contour line, though extending south of it. This great belt of gravel is generally parallel with the Niagara escarpment, and is mostly composed of Guelph dolomites, or, in some localities of *débris* from adjacent rocks. There are more or less fragments of Laurentian and Huronian crystalline rocks, intermingled with the other well water-worn material. Indeed, there are often rounded fragments of Hudson river pebbles (these coming from lower elevations).

From the eastern side of the Artemesia gravel a narrow ridge extends for nearly a hundred miles, nearly parallel to, and only a few miles distant from, Lake Ontario, known as "Oak Ridge." Its most conspicuous portion may be represented by the contour line of 650 feet above Lake Ontario, although the highest portion rises 893 feet. This ridge has an elevation of from 200 to 300 feet above the broad rock-bottomed trough on its northern side, which extends from Georgian bay to the eastern end of Lake Ontario. A spur of this ridge extends southward to Lake Ontario at Scarboro heights, a few miles east of Toronto.

There is a resemblance between the Artemesia ridges and the so-called Kettle moraines of Wisconsin, Coteau des Prairies and Coteau de Missouri. Between these ridges there is a general parallelism. The Artemesia gravel reaches 1700 feet above the sea—a height as great as portions of Coteau des Prairies.

The deposit of the Artemesia gravel is simply around the high

Digitized by Google

rocky floor of a portion of country, and marks the recession of the waters, in more or less perfect contour lines, with most of the material of local origin and stratified.

Whatever barriers may have separated the lake region from the sea, there seems no doubt that the whole area was submerged beneath the sea level to at least 1700 feet, for no glacial lake could account for the high level beaches.[2]

As the continent was rising the waters of this inland lake had many channels communicating with the exterior sea, across Ohio and New York, besides that by way of the St. Lawrence valley. Local oscillation doubtless played an important part in letting out the confined waters, but to what extent, it cannot yet be determined. Below 1200 feet above the sea-level of to-day, the principal old outlets are by the valley of Cayuga lake, at 1015 feet; by the valley of Seneca lake, at 865 feet; by the Mohawk river, at 434 feet, and by the present St. Lawrence valley, at 247 feet. Dr. Newberry enumerates various other outlets in Ohio, at 936, 968, 909, 910, and 940 feet above the present ocean level.

There is a marked connection between some of these old outlets, and the beaches which rise a few feet above them, in that they are the most conspicuous and widespread.

The explanation of much of the transported material, and especially the rocks of Hudson river formation, at localities situated higher than their original sources, can best be accounted for by the theory that they were carried upward during the time when the continent was undergoing subsidence, and that they were re-arranged by the waves and shore ice of a subsequent period.

Let us now consider the origin of *Burlington beach* and *Burlington heights*. These beaches, separating bays from the lake at different times, owe their origin to common causes. The materials for both of these beaches (whether at 8 feet or 116 feet above the present lake), were brought some distance from the northwestern side of the lake, and not from local material; for had such been brought down, their composition would be pebbles of Niagara rocks in place of those of the Hudson river formation. Moreover, the transporting power, and also the quantity of water of the

[2] Since the paper of which the above is an abstract was written, Dr. Dawson, the President of this Association, has described the occurrence of the remains of a large whale, in gravels northeast of Lake Ontario, at an elevation of 440 feet above the sea—thus proving that during the formation of some of the widespread beaches of the lake basin, there was direct connection with the sea.

Digitized by Google

streams of the Dundas valley, had become very unimportant before any of the deposits succeeding the interglacial epoch. Formerly, for the higher ridge, when the lake was 116 feet above its present surface, as afterwards for the present Burlington beach, the material was transported by shore ice and wave action to the present position of the deposits, at a time when the winters need not have been colder than at present. The pebble laden ice would naturally get piled up by the action of the winter waves (as at the present day) at the more confined end of the lake, and eventually the ice would deposit its load to form beaches. The bays at the end of the lake are now frozen over in winter, while the lake has often no more than ice-fringes. As the streams now entering the lake all do so through marshes, there would not be the slightest power from them to act against the waves to produce the present beach separating Burlington bay from the lake. Moreover, the action which built up Burlington heights moved from the open lake, as shown by the inclined bedding of the deposits.

Occurrence of Graptolites in the Niagara Formation of Canada. By J. W. Spencer, King's College, Windsor, N. S.[1]

[ABSTRACT.]

The plant-like forms, that are included in the Graptolite family, have hitherto been regarded as essentially belonging to the Cambrian and Cambro-Silurian ages. They are generally preserved in the more muddy deposits of these eras. However, there has been discovered a Canadian locality in the Niagara formation, containing a graptolitic fauna, almost as large and variable as that of the Quebec group.

In the Palæontology of New York, Professor Hall described two species of Graptolites from the Clinton shales and three species from those of the Niagara formation. Subsequently, Professors Hall and Whitfield described one other species found in

[1] Since the above paper was read, the author's address is changed to State University, Columbia, Mo.

Digitized by Google

Ohio, and Principal Dawson another occurring in Nova Scotia. The rich graptolitic fauna of the Niagara formation was discovered by the careful and continued search of Col. Charles Coote Grant (H. P. Sixteenth Regiment) at Hamilton, Ontario. From the material obtained at that city, principally by Col. Grant, I have been enabled to study out twenty-nine new species, in addition to those previously known, the whole fauna representing twelve genera, which lived in the Niagara and Clinton seas. Several other species doubtless exist, but their remains are in too fragmentary a condition for determination.

The graptolites at Hamilton occur mostly in nearly non-bituminous limestones, whose structure, under the microscope is seen to consist of recrystallized grains of dolomite. However, some of the best preserved specimens are obtained from the more shaly limestones. Owing to the condition of preservation, although the external forms are often perfect, and the chitinous substance in excellent condition, yet the cellular structure is exhibited in only occasional specimens. It sometimes happens that the impressions of the cellular orifices are well shown on the surface of the stone where the carbonaceous matter has been removed. In the study of these forms it has frequently been necessary to depend upon the relative sizes and modes of branching in order to determine the species. In many cases the solid axes of the stipes are shown to be lateral while in others they are central — a most important character.

The geological distribution is given by Professor Hall as follows: one species from the Potsdam group; fifty-three species, of twelve genera, from the Quebec group; four, from the Trenton; thirty, of eight genera, from the Utica and Hudson groups; two, from the Clinton; three, from the Niagara; one, from the Corniferous; and one, from the Hamilton group.

In the Canadian Naturalist for 1878, I described nine new species and three new genera. Of these genera, *Calyptograptus* closely resembles *Dictyonema*, with few or no cross-bars, but with branches overlapping. I have seen one species from the Niagara group of Kentucky (locally included in *Dictyonema*), and one from the Hudson group near Cincinnati, which evidently belonged to this genus. Another new genus then described was *Acanthograptus*, nearly related to *Inocaulis*, and the third was *Rhizograptus*, a cyathiform frond with slender axis and large bulbous

Digitized by Google

root. A fourth genus I have recently called Cyclograptus, which consists of a small circular frond, composed of a central disk and numerous short celluliferous stipes. (Types of the new genera were here exhibited).

The specific arrangement of the Niagara graptolites in genera is as follows:

Phyllograptus,	. .	one species.
Retiolites,	. . .	" "
Dendrograptus,	. .	six "
Callograptus,	. .	four "
Rhizograptus,	. .	two "
Acanthograptus,	. .	two "
Inocaulis,	. . .	seven "
Thamnograptus,	. .	two "
Ptilograptus,	. .	one "
Cyclograptus,	. .	" "

besides one species of *Dictyonema*, and one of *Inocaulis* not found at Hamilton.

The study of these organisms is completed as far as possible up to the present time, and in the course of a few months I hope to have it published in Part 3 (Palæontology) of the "Geology of the Region about the Western End of Lake Ontario."

A Mastodon Americanus in a Beaver Meadow. By Samuel Lockwood, of Freehold, N. J.

[ABSTRACT.[1]]

Professor Lockwood, in his paper, gave the particulars of his discovery and exhumation of the remains of a mastodon in a peat meadow about two miles west of Freehold, N. J. He had previously discovered in a peat-bog near the same village a fossil beaver-

[1] Published in full in the Montreal Herald, Aug. 25, 1882. Also in the Popular Science Monthly, January, 1883.

Digitized by Google

dam, which enabled him to detect some resemblances, and thus to suspect that this mastodon had been actually buried by beavers. This suspicion became an induction warranted by the facts which the digging disclosed, for fragments of beaver sticks were found lying across the neck of the skeleton, which lay on its right side, the tusks being deflected under the neck. The remains lay on the "hard pan" beneath the peat. It was shown that the monster died on the right bank of the ancient stream, that the beavers afterward dammed it and the pond covered the skeleton. In due time the pond was abandoned and the dam wall, as it sunk down by decay, drained the pond. As its area decreased, the area of swamp increased, and a growth of sphagnum peat buried the bones. The drainage finally became such that a meadow resulted.

The writer mentioned three instances of his finding in Monmouth County mastodon relics on the coast. Twice at long intervals were teeth obtained out at sea from Long Branch. In the other instance a part of a tusk and other bones were got from an ancient buried swamp about fifteen miles south of Long Branch, which swamp was uncovered by a severe storm from the sea.

The points made in the paper were: (1) The presentation for the first time of the evidence of the mastodon for the subsiding of a part of the eastern coast-line of the United States. (2) The long life range of the mastodon. Beginning with the Pliocene, it was shown that the individual in question was living at a period well up into very recent geologic time. (3) The mastodon came in with the great extinct fossil beaver, which it outlived, and became contemporary with the modern beaver. (4) The mastodon lived to be contemporary with the American autochthonic man, and, probably as a food supply, before him this Behemoth melted away.

Dr. Lockwood said that the tusks which were uncovered in perfection must have contained 400 pounds of ivory, but these and the bones, excepting four teeth, literally crumbled away on reaching the air, to his inexpressible grief.

Digitized by Google

Currents of Air and Ocean in connection with Climates, Regions of Summer Rains and Summer Droughts. By J. Beaufort Hurlbert, of Ottawa, Canada.

[ABSTRACT.]

The prevailing winds in the north temperate zone are from southwest towards the northeast. This great current of air may be said to be constant north of latitude 35°. In the upper region of the air it blows nearly every day in the year from some point near the southwest towards the northeast. With a constant movement of the air in high altitudes from the southwest there must be a return current from the north towards the southwest, as there are counter currents in the ocean; but these polar winds near the surface of the earth blow from all the colder points of the compass.

The warm currents of air and water falling upon western coasts, and aërial currents passing over the continents, elevate the temperatures of the western parts of the continents, while the cold currents pressing upon eastern shores lower the temperatures there.

The mean temperature of the Gulf stream in the Gulf of Mexico is 80° Fahrenheit; its maximum temperature is 86°, or 9° above the ocean temperature due the latitude. Increasing its latitude 10°, it loses two degrees of heat, and after running 3,000 miles towards the north still preserves the temperature of summer. With this temperature it crosses the fortieth degree of north latitude, and spreading out for thousands of square leagues over the cold waters of the ocean, does much to mitigate the rigors of winter in Europe. When it strikes the British islands it divides into two parts, the main current going to the Polar sea, the other entering the Bay of Biscay.

It has been estimated that the quantity of heat discharged over the Atlantic, from the waters of the Gulf stream in winter, would be sufficient to raise the whole column of atmosphere which rests upon France and the British islands from the freezing point to summer heat. Every western wind which blows (and the prevailing winds are from the west or from some point near the west or southwest in this part of the ocean) crosses the Gulf stream and carries with it a portion of its heat, discharging it in its pas-

Digitized by Google

sage over Europe. The isothermal lines of 60° and 55°, starting from the parallel of 40° on the American coast, run in a northeasterly direction, retaining nearly the same oceanic temperature on the European side in latitude 55° and 60° as exists on the American coast in latitude 40°.

In the Pacific there are tropic and arctic currents like those in the Atlantic, and from similar causes. The Japan stream, or Kuro-Siwo — black stream — a name derived from the deep blue color of its waters, flows from the southeast of Asia in a northeasterly direction, falling upon the western coast of North America. This stream, flowing many thousand miles further than the Atlantic tropic current, is not so hot nor its littoral waters so cold as those in the Atlantic, but it spreads over the entire Pacific coast of Canada. These two currents in the Pacific — the arctic and tropical — produce similar effects to those in the Atlantic; the one warming the western coast of North America, in high latitudes, and the other cooling the eastern shores of Asia.

Through the agency of these two currents in the Atlantic, the western countries of Europe are much warmer than the eastern parts of America in similar latitudes; the difference being about eight degrees in latitude 41°; eleven and a half in latitude 51°; and twenty-five in latitude 58°. Similar causes in operation in the Pacific ocean give an equal elevation of the temperature of the western coasts of America over the eastern coasts of Asia in the same latitudes — the arctic currents chilling the one and the tropical currents warming the other.

From Vancouver in latitude 49° to Sitka in 57°, the summer temperatures are as high and as uniform as in the west of Europe, except where the vicinity of mountains may modify the normal conditions of climate. Sir John Richardson says "the climate of Sitka" (on the Pacific coast) "is much warmer than that of Europe in the same parallel" (Arc. Ex., Vol. II, p. 279).

The isothermal of 60° for the three summer months rises as high as latitude 63° east of the Rocky mountains in the valley of Mackenzie river. Youkon, west of Mackenzie river and within the Arctic circle, latitude 67°, has a July 65° 7′, and an August of 60°.

In comparing the well known regions of the old world with the less known corresponding parts of the new, western coasts with western, eastern with eastern, and interior divisions with interior,

Digitized by Google

we find a remarkable similarity in the climates of the two continents. Canton, in China, latitude 23°, has a summer temperature of 82°, and Key West, in Florida, latitude 24°, 32′, a summer of 82°. Pekin, latitude 40°, has a summer of 76,° which is only two or three degrees above that of Philadelphia of the same latitude. Mangas-aka, Japan, and Charleston, South Carolina, in the same latitudes, have summers of 80°. London, in the west of Europe, and Vancouver, in the west of North America, in similar latitudes, have the same mean summer temperatures, about 61½°; Sitka, in latitude 57°, Sir John Richardson says, has a climate much warmer than Europe in the same latitude.

The climates of the interior are warmer in summer and colder in winter than those on eastern and western coasts, but are somewhat similar on both continents, being, however, warmer on the Red, Saskatchewan, and Mackenzie rivers, than in the same parallels on the eastern continent. The isothermal of 65°, for the three summer months, crosses the Red river in latitude 50°, and rises on the Mackenzie to latitude 60°.

The summer rains, too, throughout Canada, are similar to those in Europe in the same latitudes from the Mediterranean to the Arctic, being somewhat uniform during the agricultural months, but more copious in Canada.

South of the boundary between Canada and the United States, west of the Mississippi, are the areas of summer droughts — a rainless, treeless region, similar in position on this continent, and in the character of the country to the desert areas of the old world — the one beginning on the western coasts of Mexico and California, and extending to British America on the north, and over half the continent eastward; the other beginning on the western coast of Africa near the same latitude as the American desert, and extending northeastward or east by north over Africa, Palestine, Independent Tartary and Manshire Tartary, nine thousand miles in the direction of the prevailing winds.

That portion of the North American continent extending from the Atlantic westward more than 2,000 miles in the latitude of Canada, and from the Gulf of Mexico for 1,500 miles northward, is covered with a mixed forest of coniferæ and deciduous trees, which is unparalleled in extent, and in the variety and value of its woods.

These forests, so beautiful and grand in their primitive state,

Digitized by Google

have a value quite independent of their money worth. They have a most powerful and favorable influence upon the climates of the country, check evaporation, and keep the water longer in the soil, thus supplying the roots of plants, feeding the springs and streams, etc.

West of this vast forest, south of the parallel of 48° or 49°, is the treeless region. The Mississippi may be taken as near the boundary of these two zones marked with such different features, the forest in many places not reaching that river, in others extending beyond it, and again reappearing on the Pacific coast. East of the Mississippi trees appear first along the water-courses and on soils retentive of moisture, being still absent on the uplands and sandy plains. To the north this immense treeless region runs, in the country of the Upper Missouri (longitude 110° west), north of latitude 50°. Throughout these immense areas there is either a total absence of rain in summer, as in the desert parts, or an insufficiency, as on the prairies. The grasses which cover parts of these dry up in summer, but their roots, forming a deep matted sod, have vitality enough to put forth fresh shoots under the rains of spring and autumn; trees, however, which are withered up by the droughts and arid winds of summer, have no such vitality.

Vast portions of America, Africa, Asia and Australia, are destitute of trees, while other equally extensive regions are covered with forests. These treeless zones lie in similar positions on the continents, beginning near the same latitudes on the western coasts and running northeastward in the northern hemisphere, and southeastward in the southern, in the direction of the prevailing winds.

In the Old World (for Europe, Asia and Africa must, on the question of climates, be taken as one body of land) these treeless and mainly desert regions begin on the west coast of Africa, north of the twentieth parallel, and run northeastward or east by north, 9,000 miles over Africa, Palestine, northern Arabia, and Independent Tartary to latitude 50° in Mongolia, ending in the great desert of Cobi or Manshire Tartary.

In North America we have a similar desert-treeless region, beginning in old and new California and on the coasts of Mexico (in the same latitudes as the African desert), and extending to the Mississippi and beyond it, on the east, and to British America

Digitized by Google

on the north. The winds over these desert areas on both continents blow almost invariably in summer from some point near the southwest towards the northeast. These portions of the continents are destitute mainly of summer rains, but have high summer temperatures. Upon the modifications caused in these desert areas by the high lands of Mexico and the vast Mediterranean sea we cannot here enter, but may merely state that the mountains of Mexico limit the deserts there, and that great sea north of Africa causes a more humid air in the south of Europe and limits the deserts in that direction; yet Spain, Italy, Sicily, and the whole country northeastward into Hungary, frequently suffer from summer droughts.

The reason, as a permanent cause, often assigned for these portions of the continent being destitute of trees—namely, the prairie fires — cannot for a moment bear investigation.

Fires were naturally suggested to the first rude settlers, to whom the evidence of sight is the chief guide, as the only cause. In many parts of the African, Asiatic and American deserts and prairies there are no fires, still they are treeless. In other countries, fires are as frequent where forests are permanent, or, if burned down, young trees immediately grow up again. The existence of forests over a region 2,000 miles by 1,000, and their failure *where, and only where*, the summer rains fail and the arid winds prevail, ought to have suggested the explanation.

That the prairie fires sweeping over extended areas may have kept trees from some localities, near rivers or on retentive soils, is possible; but such exceptions, limited and local, have no weight in opposition to the fact that millions of square miles have remained, through all the ages of history, desert and treeless on the borders of other equally extensive areas covered with dense forests. The climates which have produced these two distinct results over those regions have remained permanent for ages, and will remain permanent in the future, unless changes supervene in the entire solar system; but for the calculation of such imaginary phenomena astronomy furnishes no data. We may infer, therefore, that those conditions of climate — heat and humidity in the one case, and heat and aridity in the other — remaining the same, their effects — forests and treeless regions — will be permanent expressions of those fixed efficient causes.

The attempts to account for the deserts of the Old and New

Digitized by Google

World by the physical configuration of the continents, have led to many ingenious theories. The chief of these is the assumption that mountain chains to the west of those rainless regions condense the vapor brought in the southwest winds, causing heavy rains on the western sides of the mountains, but leaving the winds without vapor east of these mountain chains. The phenomena of rain on the west, but none on the east of the Ghauts in Hindostan and other places, have been taken as sufficient bases for this theory.

That those regions having no summer rains are on similar parts of the continents north and south of the equator, both in the eastern and western hemispheres, beginning on western coasts at about the same latitudes; that there are no mountains west of the Desert of Sahara, and the rainless regions in Australia; that the entire coasts of Mexico, old and new California, west of the mountains, are quite as destitute of rain in summer as the regions east; that those west winds give heavy falls of rain to the north and northeast throughout Canada, and in autumn, winter, and early spring, deposit heavy rain and snow on those interior desert areas east of the Rocky mountains, over which they are said to pass in summer, devoid of vapor,—these and other facts ought to have corrected the erroneous opinions on this subject.

That the great southwest currents of air — the tropical currents —bring the vapor which falls in rain and snow, is here assumed as admitted, for it is the basis of the theory which we are controverting.

Those vast wastes are, at the season of the year when little or no rain falls, highly heated by the summer suns. The southwest winds passing over these become rarefied, and thus, being capable of sustaining even more vapor than at a lower temperature, retain the humidity with which they have come from the tropics so heavily charged, till they reach the cooler regions, north and northeast, where they are condensed into rain or snow. Hence in summer the line dividing the zones of rain from those of drought is farther to the northeast; as autumn and winter approach, those highly heated plains gradually cool sufficiently to condense the vapors in the southwest winds, which now give heavy depositions of rain and snow.

Digitized by Google

A Source of the Bituminous Matter of the Black Shales of Ohio. By Edward Orton, of Columbus, Ohio.

The great black shale of Ohio, that extends from the Huron river on the shore of Lake Erie, to the mouth of the Scioto river in the Ohio valley, with an outcrop varying from ten to twenty miles in breadth, I have already shown to be a composite stratum. In this determination, I have followed Newberry, who showed in his reports upon the geology of northern Ohio that the two black shales of Cuyahoga county, for example, the lower or *Huron* of his nomenclature, and the upper or *Cleveland*, which are there separated by a wedge of greenish blue, *Erie* shale, when followed to the westward, coalesce, through the failure of the intervening member. In his view, the Cleveland shale comes down by overlap upon the Huron, so that the black shale of Huron county consists of the blended products of the two or three formations already named. This stratum I have followed not only with no hint of interruption or division, but with manifold proofs of unbroken continuity, across the state. The name and geological place of the stratum, as assigned in the volumes of the last geological survey of the state, will both require modification according to this view. It can no longer be called the *Huron* shale, for this element constitutes only its lower portion. The boundary between Carboniferous and Devonian time can no longer be drawn at the line of junction of the Erie and Cleveland shales, for that line has disappeared, and the Cleveland shale is only the upper portion of 350 feet of black shales through which thus far no planes of division have been established.

As to the first point, I know no better name for the present, than the old one, viz.: the *Ohio Black Shale*. Professor Shaler, in his reports, upon the geology of Kentucky has reverted to this designation.

As to the place of the stratum in the geological column, I believe that it will be found necessary to refer it all to one age, viz., to the Devonian. The greater part is unquestionably of this age and for the balance, the fossils are too few, through most of the state, and too indecisive in character, to make any proper ground for establishing so important a division. I will, therefore, designate this stratum the Ohio Black Shale and I will, provisionally

Digitized by Google

at least, refer it to the Devonian age. Its approximate area I have already indicated, a belt of ten to twenty miles in breadth, extending across the state from north to south or for nearly two hundred miles. Its thickness ranges along its line of outcrop, from 250 to 350 feet.

There is another stratum of black shale in the Ohio column, of small thickness but of great persistency and extent. It lies about one hundred feet above the summit of the Ohio shale. It was first distinctly recognized and described by the late Professor E. B. Andrews, who called it the *Waverly Black Shale*. In southern Ohio, its boundaries are very distinct and definite. It is borne by the lower Waverly quarry stone, which is the continuation of the Berea Grit, for that portion of the state. The shale comes directly down upon the quarry stone. Its upper boundary is equally abrupt. It has a thickness in this region ranging from fifteen to thirty feet. Throughout central Ohio, the same description will apply, and no change is needed for the northern portion of the state except that the shale here is not always as dark in color as elsewhere, and its upper boundary is not distinct. It makes the roof of the Berea quarries, as it does of the same stratum everywhere to the southward. Meek separated it by implication from the overlying Cuyahoga shale in describing the fossils that it contains, giving to it the name of *Berea Shale*. Newberry describes it clearly but does not separate it from the Cuyahoga shale. It is charged with fossils, several of which seem characteristic.

These three beds of bituminous shale, viz., the Huron and Cleveland of Newberry and the last-named, the Berea shale, have many points of structure and history in common. They are all marine in origin, as the presence of their fossils attests. They were all formed in quiet waters and not upon shore lines, as their fine and undisturbed lamination shows. But their chief point of agreement is in the fact that is implied in one of their most common designations. They are all *bituminous* shales. According to the analyses with which I am acquainted, they carry from eight to twenty-two per cent of organic matter. It is this that gives them their color. It also renders them combustible, to a greater or less degree. There is scarcely a summer in which some of the shale banks of southern Ohio do not take fire from burning brush heaps and the like. When the conditions favor, these fires may continue for weeks or months. One is said to have lasted in the hills of

Digitized by Google

Pike county for more than two years. Some of the beds burn with a blaze.

It is this same organic matter, obviously, to which they owe their character as oil-producing shales. Oil and gas springs are constantly associated with their outcrops. They have already been turned to account for the artificial production of oil in Ohio and it is scarcely to be doubted that the great stock of carbon which they contain will at some time be utilized by man.

This organic matter has been referred both to animal and vegetable sources for its origin, and both these divisions of the living world have certainly contributed to it, for the remains of both are found in the shales, but the two factors are by no means of equal value.

The clearest and most extended statement that I know in regard to the accumulation of the bituminous matter of these shales is that made by Newberry in volume I, Geology of Ohio, page 156. He speaks of the Huron shale particularly, but what he says will apply to all of the divisions already named. I quote his words: "The nature of the sediments which form the Huron shale, the exceeding fineness of the mineral matter, the large percentage and uniform dissemination of carbon, the peculiar composition of this carbonaceous element, consisting mainly of hydrocarbons, the abundance of marine plants and the absence of terrestrial vegetation, all combine to show that it was deposited in an open sea and not immediately adjacent to the land."

"Under such circumstances we are compelled to attribute the carbonaceous matter to marine vegetation or to marine animals. If it were derived from marine animals, such as we know have contributed largely to the organic constituents of some rocks, the bituminous limestones for example, we should find much more abundant traces of their structures than we now do, since they are, in fact, almost entirely absent. We are, therefore, compelled to consider this accumulation of bituminous matter as the result of the growth of seaweeds in marine basins."

"Most marine plants with which we are acquainted grow upon the shore or in shallow water, and we can hardly imagine so large an area as that occupied by the Huron shale covered with a growth of shallow-water plants without its bearing evidence in some locality of shore lines. It is true, however, that a great growth of aquatic vegetation sometimes takes place remote from the land and where

Digitized by Google

the plants have no attachment to the bottom. Of these areas, we have a type in the Sargasso Sea, through which Columbus ploughed his way, when making the voyage that resulted in the discovery of America. There, as in other similar sheets of seaweed, the vegetation floats upon the surface of the water and maintains a vigorous and luxuriant growth without connection with shore or bottom. Corresponding to this growth must be the decomposition of vegetable tissue on a large scale. The products of such decomposition would fall to the ocean bottom as finely comminuted carbonaceous mud, mingled with stems and fronds detached by violence or decay. Under all such sheets of vegetation, in a sea where a fine mechanical sediment is being deposited, we must necessarily have an accumulation of mud, containing a large percentage of carbonaceous matter; in other words, the elements of a bituminous shale."

"Waiting the demonstrative solution of the problem which patient and exhaustive study will doubtless sometime furnish, I offer as a possible explanation of the peculiar features of the Huron shale, the suggestion that its carbon was derived from vegetation which lined the shores and covered the surface of a quiet and almost land-surrounded sea."

This statement is expanded almost to the proportions of a theory as to the origin of the black shales. In substance, it refers the bituminous matter of the shales to marine vegetation, the decomposition having been carried to such a point as to destroy almost all traces of structure.

A similar view was briefly expressed by the late Professor Andrews, in the Report of Progress of the Ohio Geological Survey for 1869. On page 65, he says, "the conditions under which this formation" (viz., the Ohio Black Shale) "was deposited, involved comparatively quiet waters, charged with a constant supply of fine sediment with which there was at all times commingled organic matter which alone could have furnished the bitumen. The even distribution of the bitumen throughout the entire mass of the sediments would imply that the water abounded with the minute forms of vegetable or animal life. Thus far, search for their forms has been unrewarded. After a failure by myself, I placed samples of the slate in the hands of Professor Wormley, whose skill in microscopic researches is well known and whose instruments are of the most perfect kind. Thus far his search for distinct organisms

Digitized by Google

has been unsuccessful. It is reasonable to suppose that the organisms contained no silica nor lime, and that in their decomposition and bituminization, all organic structure was destroyed."

Within the last year, I have discovered in the black shales of Ohio, several microscopic forms of vegetation which are found in the shales in vast numbers and which obviously constitute an important source, and, as I believe, the chief source, of the bituminous matter that characterizes the formations. A brief account of the facts, I desire to present at this time to the Association.

In the spring of 1881, I had some correspondence with Mr. J. A. Flickinger, ex-county surveyor of Ashtabula county, Ohio, in regard to a deep well, the drilling of which was in progress under his supervision, near the village of Kingsville, in the county above named. A result of the correspondence was that Mr. Flickinger kindly furnished to me the drillings that he had saved from different depths as the work had gone forward. Samples were saved every day or two and always when any change was reported in the materials through which the drill was passing. Fifty or more specimens were furnished, representing a range of between 1200 and 1300 feet.

The record that they gave was plain to read. The boring began in the Erie shale of Newberry and continued in it, with but minor changes of composition for nearly 1000 feet, where the greenish blue layers of the Erie were replaced by the black beds of the Huron. On examining with the microscope the fragments of the latter that were first reached, I found several of the samples, and notably those at 996, 1016 and 1094 feet to contain minute translucent disks, resinous in appearance and unmistakably organic in origin, in great numbers. Beyond this point, I made no progress for a number of months, until upon a microscopic examination of the black shale from Columbus, accidentally undertaken, I found it also charged with forms similar to or perhaps identical with those already recognized from the buried shale of northern Ohio. I then made examination of typical representatives of the several black shales already named throughout the state, the Huron shale from the mouth of Huron river, the Cleveland shale from Cleveland and other points in the vicinity, the Berea shale from the Ohio valley. I also examined the outcrops of the great black shale throughout central and southern Ohio, taking samples from every portion of the series, bottom, middle and top. The result of these

Digitized by Google

various examinations was that the forms already recognized or forms of the same generic character, together with a number of minute but very interesting vegetable and animal fossils, were found distributed in vast numbers, sometimes constituting a notable proportion of the rock itself, throughout the entire extent of the Cleveland-Huron shale and to a smaller extent through the Berea shale. In some localities, every fragment of the shale is crowded with the fossils; in others, the products of their decay and partial decomposition are found readily recognizable, though the fossils themselves may be comparatively rare.

I will describe in a little more detail, the first of the forms to which I particularly refer.

They are, as I have already stated, *disks*, fairly circular in outline. They are translucent and sometimes quite transparent. In color, they are prevailingly amber-like, but they exhibit many shades of brown and yellow. They are readily separable from the rock and can be favorably examined by transmitted light. In size they extend through quite a range. The smallest that I have found in any large number, come from the very base of the Huron shale in northern Ohio and are about $\frac{1}{200}$ of an inch in long diameter. Their thickness is very small comparatively. The largest, coming from near the middle or the upper half of the Ohio Black Shale reach $\frac{1}{50}$ of an inch in diameter. Some, indeed, exceed even this measure and all these become readily visible to the unaided eye. Perhaps the most common form, found in various positions in the shale, is that which has a diameter of about $\frac{1}{100}$ of an inch.

The different sizes are not, as a rule, found in the same beds. Each bed which is well charged with them will contain a very large preponderance of one general size and character. I believe that the facts in regard to them will warrant specific divisions among the forms, and further I see some reason to think that the several forms will prove to some extent diagnostic of the different horizons of the shale.

These bodies burn freely, leaving the pits in the shale from which they disappear distinct and well defined. Though resinous in appearance, they are not soluble in alcohol, ether or turpentine, or other ordinary solvents. They also disappear when the shale containing them is raised to a red heat. A few exceptions have been noted in regard to one of the rarer forms.

Their surfaces are curiously ridged and furrowed as is shown by

Digitized by Google

the bodies themselves or perhaps even more strikingly by the pits from which they have been withdrawn. Many of the latter show impressions and reliefs that resemble the track of a newly-shod horse.

What seems to be a suture or opening, occupying about one-fourth of the circumference is a common feature, and a pit for the attachment of a stem can be recognized in very many. In a few, rare instances, *the stem itself is found with the disks attached?*

These constitute the general and non-professional statements that it seems necessary to make. I submit a few drawings of the forms in question, made by one of my assistants, for the accuracy of which I can vouch. Better still than drawings, however faithful, are the objects themselves. I have a number of pieces of the shale which I shall be glad to distribute to any who care to examine them.

What are these forms and from what sources are they derived? A botanist must answer these questions when they are fully answered, as I believe. My own interpretation was substantially determined by the appearance that microscopic sections of the shale present, viz., yellow translucent circles, in sections parallel to the bedding, and elongated bars or much flattened hoops when cut transversely. These facts correspond so closely with the description of spore-cases in coals as given by Williamson and Huxley that I at first believed the forms to be lycopodiaceous sporangia. They did not, however, show the trigonal form that belongs to the spore-cases of most lycopods and certain facts that I afterwards discovered seemed to militate against this view. That they are either sporangia or spores, there seems no reason to doubt, but the facts so far accumulated would seem to indicate groups somewhat below lycopods in rank as their sources. Upon this point, I am not entitled to an independent judgment. Hoping that this interesting material may be taken up by a competent investigator, I await results.

I have spoken all along as if I were the original discoverer of these fossils of the shale. In the sense that I reached the facts without suggestion or aid from other sources, the discovery is my own, but when I came to correspond with our authorities on paleobotany, I learned from Dr. Dawson, and with very great satisfaction, that he had already had his eye upon these forms, that he had not only recognized but had figured and described, ten years ago, one of the most abundant of them. In an article entitled "*Spore Cases in Coals,*" in the April number of the American

Digitized by Google

Journal of Science for 1871, the distinguished author figures and briefly describes a form that seems, from specimens which he has kindly furnished to me, identical with the one which I at first recognized, that came from 1000 feet below the surface in northern Ohio. This account is brief and I will give it entire.

"The oldest bed of spore-cases known to me is that at Kettle Point, Lake Huron. It is a bed of brown, bituminous shale, burning with much flame and under a lens is seen to be studded with flattened disk-like bodies, scarcely more than a hundredth of an inch in diameter, which under the microscope are found to be spore-cases, slightly papillate externally, and with a point of attachment on one side and a slit more or less elongated and gaping on the other. I have proposed for these bodies the name *Sporangites Huronensis*. When thin slices of the rock are made, its substance is seen to be filled with these bodies which, viewed as transparent objects, appear yellow like amber and show little structure except that the walls can in some instances be distinguished from the internal cavity and the latter may be seen to inclose patches of flocculent or granular matter. In the shale containing them, there are also vast numbers of rounded, translucent granules which may be the escaped spores."

"The bed at Kettle Point is stated in the report of the Geological Survey to be twelve to fourteen feet in thickness, but to what degree either in its thickness or horizontal extent, it retains the characters above described, I do not know. It belongs to the Upper Devonian, being supposed to be a representative of the Genesee shales of New York. It contains stems of *Calamites inornatus*, and of a *Lepidodendron*, obscurely preserved, but apparently of the type of *L. Veltheimianum* and possibly the same with *L. primœvum* of Rogers. The spore-cases are not improbably those of this plant, of the species of *L. gaspianun* which belongs to the same horizon though not found at this locality. The occurrence of this bed is a remarkable evidence of the abundance of lycopodiaceous trees, whose spores must have drifted in immense quantities in the winds to form such a bed. It is to be observed, however, that this is not a bed of coal, but a bituminous shale of brown color, and with pale streak, no doubt accumulated in water and even marine, since it contains *Spirophyton* and shells of *Lingula*. In this it agrees with the Australian Tasmanite which, though composed, in great part, of spore-cases of ferns is, as I am informed by Mr. Selwyn, an aqueous deposit, containing marine shells."

Digitized by Google

A number of other organic forms are associated with the spores in the black shales. In fact a flora and a fauna of considerable interest are coming to light in these hitherto neglected strata. They have long been known to contain *Lingulas* and *Discinas* and also *Conodonts*, whatever they may be. The bones, plates and teeth of fishes, large and small, have also been found in them, sometimes in great abundance and sometimes though rarely, of surpassing paleontological interest. It is below all of these groups that the forms to which I refer are to be found. Microscopic in size undetermined in character, but invested with both geological and paleontological interest, a considerable harvest awaits the careful student of these hitherto unrecognized forms.

I will not occupy the time of the Association with crude descriptions of such other forms as I have recognized, but leaving this branch of the subject, I will ask you to consider for a few moments, an important office that these minute bodies seem to have rendered and to be still rendering.

The office to which I refer is the production of the great accumulations of petroleum and gas that have been found in the Devonian and sub-carboniferous formations of Pennsylvania, West Virginia and Ohio written the last twenty-five years.

Thanks to the great work carried forward by the second Pennsylvania survey, we are coming to a pretty clear understanding of the geology of petroleum so far as its stratigraphical relations are concerned. This much we know, the great repositories are lenticular masses of sandstone and conglomerate, inclosed within masses of fine-grained shales, sealed up, as we may say, within them, but not quite hermetically. Below these oil sands, heavy deposits of shale, blue, red and black, are known to exist and at still greater depth the Devonian and Silurian limestones are found.

What are the sources of these great accumulations of hydrocarbons that have become in the last quarter of a century an important factor in the commerce of the world? There are but three answers to this question that so far as I know the geologists of our day have to offer. I will state them, but my limits forbid their discussion.

The first answer is that the petroleum and gas with which the oil sands are charged are indigenous to these sand and gravel deposits, formed within them from the decomposition and transformation of land or marine vegetation with which these old beaches have been charged. I scarcely know to whom to credit this

Digitized by Google

theory, but Professor Lesley refers to it frequently with evident approval.

The second theory is that of Dr. T. Sterry Hunt and is to the effect that the animal matter of the great limestones and notably that of the great Devonian sheet, the Corniferous limestone, is an adequate source of these vast reservoirs of oil and gas. Dr. Hunt has made calculation of the amount of oil that could be furnished by such a bitumen-bearing bed as the Bridgeport limestone of Chicago of Niagara age.

The third theory is that of Newberry. At least, the answer to which I now refer has been presented by him in more detail and defended with more painstaking and ability than by any other, so far as I know. His first extended statement appeared in an article in the Agricultural Report of Ohio for 1869, under the title of "The Rock-Oils of Ohio." I will give some of the main points on which Dr. Newberry relies in establishing the last named theory.

He takes the ground that the great source of petroleum and gas in the field already named, is the bituminous matter of the black shales of which I have been treating. The points that he makes are the following: —

1. The hydro-carbonaceous matter required for such a supply is really present in these shales. Analysis shows them to contain from ten to twenty per centum of organic matter of this character, requiring comparatively little transformation to be converted into the bodies whose origin we are seeking. A ton of these black shales is made to yield in our retorts, from ten to twenty gallons of oil, as a matter of practical business.

2. A line of oil and gas springs marks the outcrop of these formations throughout their whole extent, showing unmistakably that they do give rise everywhere and always to these very products. In other words, the shales are undergoing spontaneous distillation by which these products appear wherever the formations themselves are uncovered.

3. The productive wells of the oil fields actually descend to or near to these shale horizons. When limestones hold oil, as the Corniferous of Canada, Dr. Newberry argues that below them still beds of black shale are to be found as the Utica for example. Wells bored below these Devonian black shales in Pennsylvania, even to the great limestone sheet, are comparatively unproductive. The Corniferous has been struck more than once in the deep wells of Pennsylvania and New York without any large returns.

Digitized by Google

This view has so much to recommend it that it is not surprising that it has won more general acceptance than any other. In the most complete accounts yet given of the geology of an oil producing district, viz., in the late reports of Carll of the Pennsylvania survey, this theory seems to be adopted as furnishing the best available explanation of the facts involved.

The facts to which I have called the attention of the Association at this time are in harmony with this view and may advance our knowledge by one step of the history of these products, but they do not touch the question in a vital or decisive way. Granted that the black shales are the source of petroleum, I have pointed out the particular element of the shales that is engaged in the work. The really vital fact was already held, in the knowledge that analysis has given us of the composition of the shales. It is their ten per centum of hydro-carbonaceous matter that takes the central place in the argument.

If these various *sporangites*, to adopt Dawson's generic designation, prove to be true sporangia, this fact, as I have said, carries us forward by a step at least in the way of accounting for the origin of petroleum and the other hydrocarbons associated with it. Such bodies, lycopodiaceous spores, for example, as Dawson and Hunt and others have shown, partake of the qualities common to most suberine and epidermal matter. Being extremely rich in hydrogen and carbon they approach resins and fats in composition more nearly than they do woody fibre. Hence they repel water — are not easily moistened and are able to resist decay in a remarkable degree. All of these facts bear upon their contribution to and preservation in the beds of coal and shale of which they form a conspicuous part.

Whatever their value shall be found to be in the production of oil and gas, I have shown by the facts here recorded that the bodies in question are universally distributed throughout the Devonian and sub-carboniferous bituminous shales of Ohio and, by fair inference, through all adjacent territory. Let me recapitulate the facts that bear on this question of distribution.

Dr. Dawson first found these *sporangites* on Kettle Point of Lake Huron, but expressly disclaims knowledge of either their vertical or horizontal distribution beyond the twelve or fifteen feet there exposed. They are next found 1000 feet below the surface in northern Ohio. They are rediscovered in the middle or upper division of the Ohio black shale at Columbus. Then by a more systematic search, as opportunity has offered, they are found in

Digitized by Google

every portion of the Cleveland-Huron black shale of Ohio, from bottom to top and from Lake Erie to the Ohio river. They are also distributed throughout all the most characteristic portions of the Berea shale. I regret that I have not had opportunity as yet to examine the extension of these strata elsewhere, but it is not at all hazardous to assert that whoever looks for them in the Hamilton black shales of western New York, in the Devonian black shales of Michigan and Indiana and in the southwest extension of the Ohio black shale along the eastern border of the Cincinnati axis across Kentucky and Tennessee, will find them there in the same associations and conditions that have been here described. Dr. Newberry indeed has informed me that a number of years ago he recognized spores in the black shale of Kentucky.

RECENT INVESTIGATIONS AND PALÆONTOLOGICAL DISCOVERIES IN THE WAPPINGER LIMESTONE OF DUTCHESS AND NEIGHBORING COUNTIES, NEW YORK STATE. By WILLIAM B. DWIGHT, of Poughkeepsie, N. Y.

[ABSTRACT.]

THE Wappinger (or Barnegat) limestones of Dutchess and the neighboring counties, New York state, can be properly studied only in connection with the Poughkeepsie slates with which they are closely interstratified. Recent explorations in both the limestones and the slates, but chiefly in the former, have had rich results. These results are important for the following reasons:

(1) The age of these rocks has been hitherto very uncertain. Emmons classed them as Taconic. Mather, with the approval of Professor Hall, called the slates Utica and Hudson River, and the limestones Calciferous and Trenton. In later years, after a review of the region, Sir William Logan and Professor Hall have published the whole belt as "unfossiliferous Quebec."

(2) The question of the age of the Wappinger limestones and the adjoining strata, has an important bearing on that of the existence of the so-called Taconic system. There have been, in recent years, many investigations by eminent geologists into the true nature of the original typical Taconic rocks. On the whole, these have impaired seriously the theory in regard to them, held by

Digitized by Google

Emmons, if they have not destroyed it entirely, in general scientific opinion. Prof. J. D. Dana, after detailed personal observation, has recently, in the American Journal of Science, contributed weighty, and, as I believe, conclusive evidence of the continuity and identity of the slates and limestones of Dutchess county and their modifications, with the Taconic rocks of Emmons in western Massachusetts and Vermont. Palæontological evidence as to their age would therefore be decisive as to that of the Taconic strata of the above mentioned states.

This evidence, now ample, shows the so-called original Taconic strata to contain the Hudson river, Trenton, Chazy and Calciferous groups, and probably also the Potsdam sandstone. This result harmonizes with palæontological evidence furnished by A. Wing and other observers in the northern extension of the Taconic in Vermont.

(3) While conclusions concerning the Dutchess county rocks have been heretofore founded almost entirely on stratigraphical grounds, since 1878 abundant palæontological evidence has been found. In 1878, Mr. T. N. Dale found many Hudson river fossils in the slates west of the limestone belt. In 1878 and '79 Professor Dana discovered Trenton fossils at Pleasant valley and Rochdale, near Poughkeepsie, in the limestone. In 1879, Mr. R. P. Whitfield discovered the Chazy *Maclurea magna* in the continuation of the Wappinger limestone at Newburgh. In 1879, the writer, by invitation of Professor Dana, accompanied him and assisted in the discovery of the Trenton fossils at the localities above named. Since that date I have continued a most careful exploration of the limestone, with very rich results. I have been able to develop more fully the fossils in the Trenton, and also for the first time to find abundant evidence, by fossils, of the presence of the Calciferous group in extensive deposits. I have been able to trace out to a large extent the mutual relations of the Hudson river slates, and the Trenton and Calciferous limestones. It appears that they are disposed in at least three anticlinal folds, with many local complications. The general strike is about north 30° east (true), and the average dip about 70° easterly.

Partial metamorphism has generally obliterated and always affected the fossils, but a very close scrutiny has revealed a number of interesting fossiliferous localities. Of these, Rochdale,

Digitized by Google

four miles northeast from Poughkeepsie, is by far the richest. I have found fossiliferous Trenton at different points from Salt Point, ten miles northeast of Poughkeepsie to about eighteen miles to the southeast of that city. Fossiliferous Calciferous appears as far to the north, but none has as yet been found farther south than a point five miles below Poughkeepsie.

The Trenton fossils found by Professor Dana at the time above mentioned were *Orthis tricenaria* and *testudinaria*, *Leptæna sericea*, *Strophomena alternata*, *Orthoceras junceum*, cyathophylloid corals, several crinoid species, and a very minute coral since identified by Professor Dawson as the *Chætetes* (*stromatopora*) *compacta*, previously reported in Canada. Part of an *endoceras*, and a large species of *receptaculites* were also found. A fossil appearing to be *Orthis occidentalis* had also been found by him at Ancram.

My own explorations in the Trenton of the Wappinger valley have developed, in addition to the above fossils, *Orthis pectinella* and *lynx*, *Rhynconella capax*, *Chætetes lycoperdon*, var. *ramosa*, *Petraia corniculum* (probably), *Illænus crassicauda*, a head and columns of *Echino-encrinites anatiformis*, columns of *Schizocrinus nodosus*, a new species of discinoid brachiopod which I have named *Orbiculoidea conica*, and many fragments of columns of a large *encrinite* of the Canadian "cleiocrinus" type, two centimetres or less transverse diameter. Some of these are too close to *C. magnificus* and *grandis* to be assigned to any other species, though the latter forms are sometimes much larger than the type specimen. Others present considerable variation from these types.

The most remarkable fossils are those which I have discovered in the Calciferous, chiefly at Rochdale. These comprise, of Calciferous fossils of general occurrence in the United States, *Ophileta complanata*, *sordida* and *levata*, and several species of fucoids; of well known Canadian fossils, *Ophileta compacta* and *Triplesia* (*Camerella*) *calcifera*. *Ophileta compacta* has previously been reported from a single locality in the United States, near Middlebury, Vt., by Mr. A. Wing.

There are also a large *holopea* resembling *H. proserpina*, and smaller ones not identified; *pleurotomariæ* resembling *P. Canadensis*, *quebecensis* and *gregaria* of Canada; a minute *ophileta*, new species; a *Murchisonia* resembling *M. gracilis* of the Trenton group; several other gasteropods not identified; one or two species

Digitized by Google

of quite small and finely striated *orthides;* many undeterminable fragments of *Bathyurus;* also several specimens of *Chætetes lycoperdon*, var. *ramosa*, well marked. The latter is not, I believe, hitherto reported below the Trenton.

Of *Orthocerata*, I have been surprised to find at least from *twenty-five to thirty species* in this Calciferous rock. Unless *Orthoceras primigenius* may be present, which is doubtful, and excepting *Oncoceras mummiforme* (Whitfield) which appears to be represented, all are new forms in the United States Calciferous. All have close septa, none having wider septa than nine to the inch, among hundreds of specimens collected. Most have from fifteen to thirty-five or more septa to the inch. The species vary in length from under two to twenty-three centimetres, and in breadth from under one to over four centimetres. Curved forms and lateral, mostly marginal siphuncles, predominate. There is also a predominance of large siphuncles of the endoceras type, but generally lacking the internal cone. There is much variety in the shape of the siphuncles and in the taper and shape of the shell. Some of these resemble, and may prove identical with, the Canadian species "Montrealense," "glaucus," and perhaps one or two others, but a large part appear to be new species. Two of these orthoceratites are evidently "endoceras," bringing this genus down to a low horizon.

One of the more common and beautiful species is from one to two inches long, with six to eight annulations, and twenty to forty septa to the inch.

Two species of *lituites* occur here, and a *cyrtoceras* with the marginal siphuncle on the side of the inner curve.

From the above statements it will appear that both the Trenton and Calciferous strata of this region differ greatly in palæontological character from other strata of those ages in the United States, while they resemble the strata of Canada, or of perhaps, some of the localities of the United States immediately bordering on Canada.

It would also appear that the Wappinger limestone, contrary to its received unfossiliferous reputation, is highly "fossiliferous," and that Rochdale, its most interesting locality, is the richest palæontological locality of the Calciferous in the United States, and one of the richest in cephalopodic life of any formation in the country.

Digitized by Google

THE WINOOSKI MARBLE OF VERMONT. By G. H. PERKINS, of Burlington, Vt.

[ABSTRACT.]

THE object of this paper was to call attention to the remarkable deposits of variegated marble which extend along the western border of Vermont for about thirty-five miles, from near Burlington north beyond St. Albans. Quarries have existed in some of the beds for thirty years; but recently more extensive operations than formerly have more than ever before developed the variety and beauty of the marble. The beds are primordial in age and form a part of the "Red Sandrock" of western Vermont. The marble is a dolomite and consists of magnesia carbonate about forty per cent, lime carbonate thirty per cent, silica ten per cent, and about the same amount of iron and alumina, but its constitution is very variable. It is not generally fossiliferous, but in some layers, *Salterella pulchella* Billings, occurs in patches and other indistinctly marked fossils have been found, but they are very rare. The predominant color is red mingled with more or less white; less common are green and drab tints. Of red almost every imaginable shade occurs and the variety which is produced by the mingling of these different shades with white and green or drab is wonderful. Over thirty well marked varieties are found within a short distance of the large mill recently built on Mallett's Bay about six miles from Burlington. All of these are handsome. In some the color is dark Indian red and from this the varieties pass to a light shell pink and these latter are exquisitely delicate and beautiful.

The supply is practically unlimited and so located on the bay, which is a part of Lake Champlain, that the derrick which lifts the blocks from the quarry can swing them around and deposit them in boats lying alongside by which they may be taken to the Hudson and St. Lawrence. Though harder and hence more difficult to saw and cut than common marble, the Winooski, or as it is now called the Wakefield, compensates for this by its durability, superior polish and general beauty, and it seems destined to prove of great value for wainscoting and other ornamental work in fine buildings. Specimens of some of the chief varieties were exhibited, and others described.

Digitized by Google

The Great Terminal Moraine across Pennsylvania. By H. Carvill Lewis, of Germantown, Pa.

[ABSTRACT.]

After describing the investigations in New Jersey, and along Long Island and southern Massachusetts, which first demonstrated the existence of a true terminal moraine, and referring to the discovery of similar moraines in Wisconsin and Minnesota, which marked halting places in the retreat of the glacier, the author stated that, having obtained the aid of the Geological survey of Pennsylvania, and, during a portion of his work, the assistance of Prof. G. F. Wright, he had been able to follow and define the southern limit of glaciation for the first time in a continuous line four hundred miles in length across that state, and to find that it was everywhere marked by a remarkable accumulation of glaciated material, which, winding across mountains and valleys, from the lowlands of the Delaware to the great Alleghany plateau, was continuous from end to end, and formed a true terminal moraine to the great ice-sheet that once covered northeastern America.

The method employed in discovering the line of the moraine was to zigzag along its course from the glaciated into the non-glaciated region, and *vice versa*, going each time far enough on the one side to be fully satisfied of the absence of glaciation, and on the other to find undoubted traces of its action.

He then spoke of the marked distinction between the glaciated portion of Pennsylvania and that region south of glacial action. Although the general topography of the two regions is alike, the varied superficial features due to glacial agencies, the far traveled and scratched boulders, the smoothed and striated rock exposures, the unstratified deposit of *till*, the many *kames*, and especially the numerous glacier-scratched fragments and pebbles, — all these deposits are in strong contrast with those south of the moraine, where all the gravels are stratified and the pebbles water-worn, where the rocks are never polished or striated, but, on the other hand, often decomposed to a great depth, and where, except near the seacoast, wide stretches of the more elevated regions are perfectly free from all drift.

Nowhere south of the line of the terminal moraine had the author found any traces of glacial action, all statements by other geolo-

Digitized by Google

gists to the contrary notwithstanding. When typically developed, the terminal moraine is characterized by peculiar contours of its own. A series of *hummocks*, or low conical hills, alternate with short straight ridges, and enclose shallow basin-shaped depressions, which, like inverted *hummocks* in shape, are known as *kettle holes*. Large boulders are scattered over the surface, and the unstratified *till* which composes the deposit is filled with glacier-scratched boulders and fragments of all sizes and shapes. The average width of the moraine is about one mile.

At many places, however, the limit of glaciation is marked merely by an unusual collection of large transported boulders. This is especially the case in front of a high mountain range, which has "combed out" the drift from the ice.

The general course of the moraine across Pennsylvania was defined as follows: appearing first in Northampton county, a mile below Belvidere, at latitude 40° 49′, it rises through the stratified drift as low gravel hills, which, winding up over the slate hills to the west, are soon developed into an accumulation of typical till, holding kettle holes and filled with boulders. Winding in a great curve first westward and then northward, it reaches the base of the Kittatinny mountain three miles east of the Wind Gap.

Ascending to the top of the Kittatinny mountain, 1600 feet high, the moraine crosses over it, being well shown upon the very summit, and entering Monroe county, crosses the great valley between the Kittatinny and the Pocono, enclosing in its course several moraine lakes. Having crossed this valley, and reached the base of the Pocono escarpment, it swings sharply back and around Pocono Knob, immediately afterwards to ascend the steep face of the mountain to the wide plateau on top, 2100 feet above the sea. Crossing this in a fine curve, and heaped up in an immense accumulation, it goes first north and afterwards west, until it reaches the Carbon county line.

Crossing the centre of Kidder township, Carbon county, it reaches the gorge of the Lehigh river, some ten miles north of Mauch Chunk. It crosses the gorge at Hickory run, and, without swerving from its general northwestern course, ascends mountain range after mountain range in Luzerne county, descends to the valley of the east branch of the Susquehanna, and crosses the river at Beach Haven, here forming immense heaps of drift, afterwards to be washed down the river into terraces.

Digitized by Google

Then, in Columbia county, following along the base of Huntington or Knob mountain for awhile, it finally ascends it, and crossing over the summit, at a height of 1500 feet above the Susquehanna just below, descends the north slope of the mountain to the broad undulating valley to the north. Taking a northerly course, it follows up on the east bank of Fishing creek to the North or Alleghany mountain. The summit of the Alleghanies in Sullivan county is covered with glacial striæ, and contains boulders and other marks of glaciation. The moraine entering Lycoming county, passes westward along the base of the mountain, crossing in its course the Muncy and Loyalsock creeks, and finally, near the village of Loyalsock, turns at right angles and ascends the mountain.

Having reached the summit of the Alleghanies, over 2000 feet above the sea, it crosses the picturesque cañon of Lycoming creek, and passing west through a wild, wooded region nearly as far as Pine creek, it begins a nearly straight northwestward course, through the southwest corner of Tioga county, and the northwest part of Potter. In the high ground of Potter county, the moraine crosses a great continental watershed, from which the waters flow into the gulf of Mexico, Lake Ontario, and Chesapeake bay. The moraine is here finely shown at an elevation of 2580 feet, being higher than elsewhere in the United States.

The line of the moraine now enters the state of New York, in the southwest corner of Allegany county. Passing still northwest and entering Cattaraugus county, it twice crosses the winding course of the Allegheny river, east and west of Olean; then trending to a point five miles north of Salamanca, in latitude 42° 15′, it forms a remarkable apex, whence to the Ohio line its course is southwest. Turning at right angles to its former course, the moraine passes southwest through the southeast corner of Chautauqua county, and, keeping approximately parallel to the course of the Allegheny river, reënters Pennsylvania, in Pine Grove township, Warren county. It crosses the Conewango river seven miles north of Warren, forming immense accumulations in the valley of the river.

Then trending west in Warren county, still at a general elevation of nearly 2000 feet above the sea, the moraine crosses one gorge after another, and forms a line separating, not only the gla-

Digitized by Google

ciated from the non-glaciated region, but also the cultivated from the uncultivated and densely wooded region.

In Crawford county, the line appears in the southeast corner, and crosses Oil creek between four and five miles northwest of Titusville.

In Venango county it skirts the northwest and west boundary of the county, crossing French creek four miles west of Franklin.

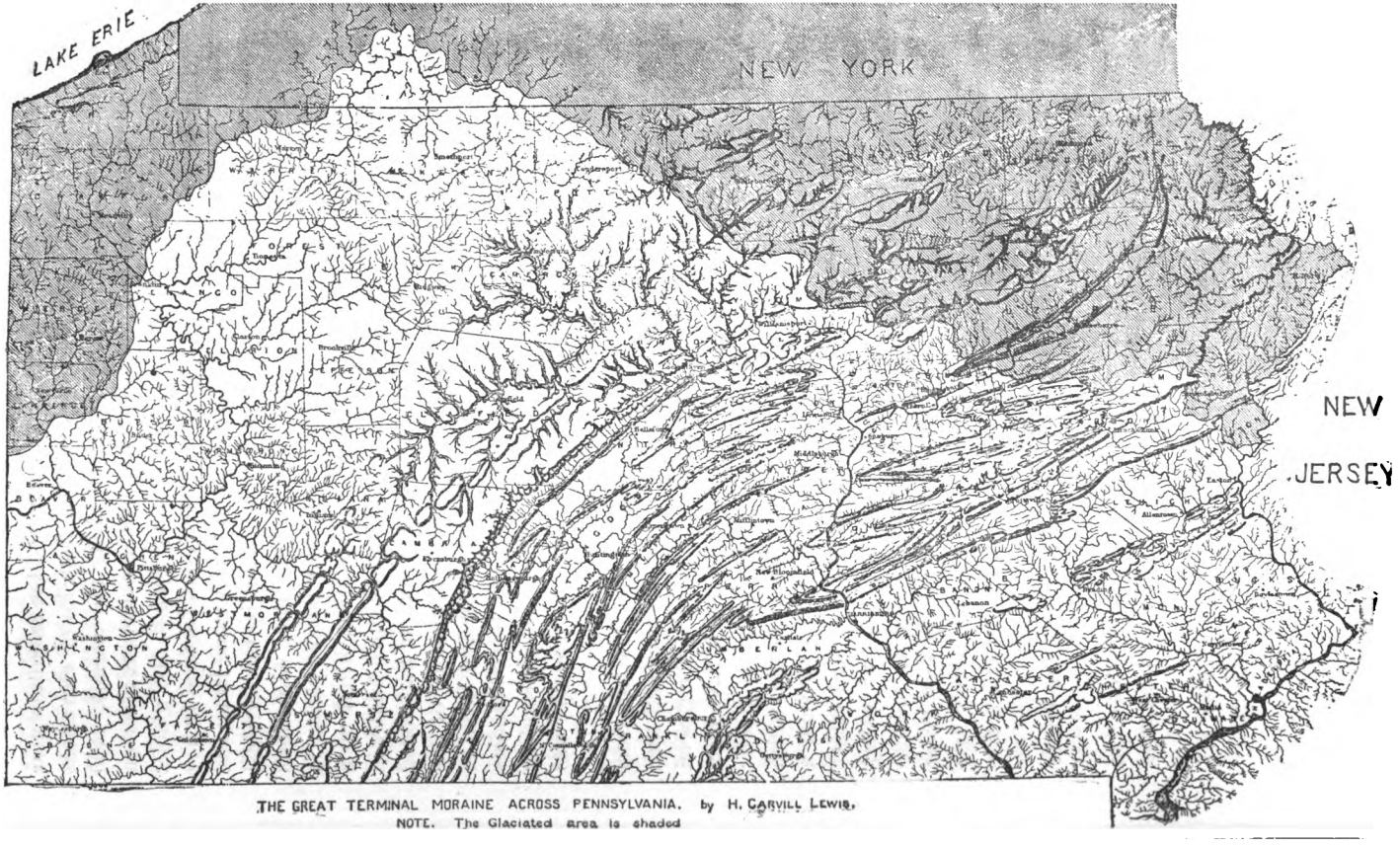
It crosses the three northwest townships of Butler county, and the southeast corner of Lawrence. The Beaver river is crossed by the moraine eight miles south of New Castle.

The moraine traverses the extreme northwest corner of Beaver county, and, in the middle of Darlington township, thirteen miles north of the Ohio river, and at a latitude of 40° 50′, crosses the Ohio state line.

The moraine thus leaves Pennsylvania at precisely the latitude at which it entered the state, and if a straight line were drawn across the state between these two points, the line of the moraine would form with it a nearly right-angled triangle, whose apex was 100 miles distant perpendicularly from its base. The total length of the moraine, as here shown, is about 400 miles. The moraine crosses the Delaware at an elevation of 250 feet, the Allegheny at an elevation of 1425 feet, and the Beaver at an elevation of 800 feet above the sea, or 225 feet above Lake Erie. Upon the high lands it rises higher by 1000 feet or more.

Coming to the details of the moraine, the author spoke of the fine development of the moraine in Northampton county, west of Bangor, where it forms a series of hummocky hills, which, 100 to 200 feet in height, and covered with transported and striated boulders, rise abruptly out of a clayey plain to the west. Glacial striæ upon exposed surfaces near Bangor point southwest, or towards the moraine. After following the moraine to the base of the Kittatinny mountain, it became of great interest to know whether a great lobe of ice descended from New Jersey along the lower side of the mountain, or whether a tongue projected through the Delaware Water Gap, or whether the glacier even so close to its southern limit, came bodily over the top of the mountain, unchecked by it, and unchanged in its course. The last, the most improbable of these hypotheses, and certainly the least expected by the author, proved to be undoubtedly the true one. The author

Digitized by Google



THE GREAT TERMINAL MORAINE ACROSS PENNSYLVANIA. by H. Carvill Lewis.
NOTE. The Glaciated area is shaded

Digitized by Google

had been able to show that the moraine crossed the mountain near Offset Knob, that large boulders, derived from lower elevations several miles northward, lie perched all along the summit, 1400 feet above the sea, and that, as shown by the numerous striæ on the northern slope of the mountain, running *up-hill*, the glacier moved diagonally up and across the mountain, uninfluenced in any way by the presence of the Water Gap, and finally came to an end in the valley south of the mountain, as marked out by the terminal moraine. Huge boulders of fossiliferous limestone, sometimes thirty feet long, were torn by the ice from their parent strata in Monroe county, on the north side of the mountain, lifted up a thousand feet, carried across the mountain, and dropped finally in the slate valley of Northampton county. The author had found one of these limestone boulders upon the very summit of the mountain, where the jagged sandstone rocks had combed it out of the ice during its passage across. The journeys of these boulders were short, but that of a well-rounded boulder of Adirondack syenite, which the author had found in the same county, was about 200 miles.

In Monroe county, the course of the moraine as it winds from the top of the Kittatinny mountain down to Cherry valley and then up again on to the Pocono, is a complete vindication of the glacial hypothesis. It is in no sense a water level, nor could it have been formed by floating ice. No other cause than that of a great glacier could form a continuous accumulation of glaciated material, which contains no evidences of water action and which follows such a course. The fact that no tongues of ice were protruded either through the Delaware Water Gap or down the broad valley between the Pocono and Kittatinny mountains, indicates the immense size of the glacier. Although more than 1000 feet lower than the mountains and twelve miles in width, the valley last mentioned deflected the southern boundary of the ice but a few miles.

There are no striæ indicating passage of ice through the Water Gap, the supposed striæ being due to water action.

Again, neither on the mountains nor in the valley does the moraine rest against any defined barrier as would be the case were it a shoreline.

Of special importance in this connection are the two facts: (1) that, as shown by the absence of stratification, by the angularity

Digitized by Google

and the striated surfaces of its enclosed stones, and by its topographical position, it has rarely been subjected to the action of water; (2) that, as proved by numerous glacial striæ and by transported boulders, its course is always at right angles to the direction of glacial movement.

The author stated that the moraine was wonderfully shown upon the summit of Pocono mountain, over 2000 feet above the sea, where a great ridge of moraine hills twelve miles long, one mile wide, and 100 or more feet high, composed of unstratified till, and bearing numerous boulders of Adirondack gneisses and granites, lies upon the level, sandy plain of the Pocono plateau and sweeps around from Pocono Knob into Carbon county. Known locally as "Long Ridge," its origin had never before been suspected. It encloses remarkable little "moraine lakes" without inlet or outlet, and is heaped up into just such conical hills as may be seen in the moraine in southern Massachusetts. Nothing can more clearly show the continuity and uniformity of action of the great glacier than the identity of its moraine accumulations at such remote points.

The author here described the *kames* of Cherry Valley, fine examples of which appear south of Stroudsburg, and are interesting relics of sub-glacial water action. They are composed of stratified water-worn gravel, having often an anticlinal structure, and, as a series of conical hills and reticulated ridges, enclosing "kettle holes," form conspicuous objects in the centre of the valley. They appear to have been formed by sub-glacial rivers, which flowing from the moraine *backwards*, under or at the edge of the ice, emptied into the Delaware valley. He thought that a study of the great subglacial drainage, of which kames are the most prominent relics, would throw much light upon certain high-level stratified gravels whose origin has been ascribed to great changes of elevation.

The author then described the more interesting glacial striæ of Monroe county. One of these, on the north side of the Kittatinny mountain, was six feet wide and seventy feet long. Near the moraine the striæ always curved so as to keep at right angles to it.

He spoke of the very slight effect that the glacier had upon the topography of Pennsylvania. It neither leveled down mountains nor scooped out cañons. The glacier passed bodily across the sharp edge of the Kittatinny mountain without having any appreciable effect upon it, the glaciated part of the ridge being as high

Digitized by Google

and as sharp as that part south of the moraine. In describing the course of the moraine across Carbon county, he referred to the numerous lakes due to glacial action as being of two kinds: — moraine lakes, or kettle holes in the moraine holding water, and dammed up lakes, due to the obstruction of streams by the unequal distribution of the till. He spoke of the sharp distinction between the glaciated and the non-glaciated region on the Lehigh river, and referred to the striæ upon the summit of Penobscot Knob, which, at an elevation of 2200 feet above the sea point S. 10° W., this being the general direction of the ice flow. On the other hand, in the valley at White Haven, immediately below, the striæ point southeast, or along the valley. He spoke of the importance of separating the high level from the low level striæ, the former indicating the general movement of the top of the ice, which is uniform over large areas, while the latter conform more or less to the valleys and show mere local movements of the base of the ice. The glaciation of Penobscot Knob showed that the ice was at least 2000 feet thick at a point eight miles back of its extreme edge. Data were given, leading to the conclusion that the extreme edge of the glacier had a thickness varying from 400 to 900 feet.

In describing the course of the moraine across Luzerne county, the author showed that it crossed several mountain chains in succession, by each of which it was locally deflected northward.

He stated that at the point where the terminal moraine crosses Buck mountain, in a line diagonally across the mountain, the moraine was so sharply defined that he was able to stand with one foot upon the glaciated and the other upon the non-glaciated region. He described the fine kames between Scranton and Pittston, on the Lackawanna river, and showed that they were nearly parallel to the glacial striæ.

He then gave some details of the course of the moraine as traced through Columbia county. He stated that it was interesting to find that in *front* of a mountain chain, such as Huntington mountain or the Allegheny mountain, the moraine was poorly developed, as though the mountain had *combed out* the drift from the ice.

He described an instructive portion of the moraine, where, three and one-half miles northwest of Berwick, it seems to abut against a high slate hill, which furnishes, therefore, a *section* of the end of the glacier. It shows that the extreme edge of the ice was about 400 feet thick, and that while the moraine and the scratched pebbles

Digitized by Google

were carried along at the base of the ice, sharp fragments of sandstone were carried on top.

The interesting course of the moraine along the eastern bank of Fishing creek was described, where the glacier stopped abruptly on the downward slope of a hill, stopping simply because its inertia became exhausted. Where the moraine crossed the creek, it formed a great dam, and it was shown that the moraine was often steeper at the back than at its front edge — a fact analogous with the features of modern Swiss moraines.

The evidences of glaciation upon the Allegheny mountain in Sullivan county were given, the striæ pointing south 9° west, and the moraine was followed along the base of the mountain to a point in Lycoming county near Loyalsock, where it climbed up to the great Allegheny plateau, and then, keeping at a high elevation, passed through Tioga and Potter counties into New York.

That this great region of high elevation (over 2500 feet) had a decided influence upon the general course of the moraine was inferred from the local influence already shown by the author to have been exerted by single mountain chains, and he thought it probable that as the lowlands along the Atlantic allowed the ice to flow as far south as Belvidere, so this great mountain region, acting like a wedge, caused the moraine to swing northward into New York; and so, too, the depressions of Lake Erie and the Mississippi valley produced another and more extended southward flow, a portion of which traversed the western part of the state.

Professor Lewis here described the remarkable apex made by the moraine north of Salamanca, N. Y. He showed that it was probable that the Allegheny river flowed under a tongue of the glacier, ten miles broad and two miles long, through a sub-glacial channel at the time of its greatest extension near Olean. He described a great natural dam across the valley of Great Valley creek, near Peth, where the moraine stretches across the valley from side to side, and he spoke of the contrast between the numerous drainage valleys which drained the waters of the melting ice into the Alleghany river, and those valleys which took their rise south of the moraine and were free from all drift.

After giving some details of the western lobe of the ice sheet in Pennsylvania, and referring to its agricultural significance, he spoke of some curious deposits of glaciated material which occurred in a narrow strip of ground immediately in front of the

Digitized by Google

moraine, and which he had named the *fringe*. These deposits consisted of boulders of Canadian granite, and other rocks, which he found perched upon the summits of hills, sometimes as far as five miles in front of the moraine, though never farther. This glacial "fringe," confined to the western part of the state, was found to increase in width from two miles in Warren county, to five miles on the Ohio line, and was at first a puzzling phenomenon. The hypothesis proposed was that, like breakers on the seashore, the top of the ice overreached the lowest strata by the width of the "fringe," and that while the moraine marked the halting place of the bottom of the ice, by which it was formed, the far-transported boulders were carried on more rapidly in the top strata of the ice, and were dropped outside of the moraine to form the "fringe." It was stated that the striæ in the western part of the state all pointed southeast, being at right angles to those in the eastern part of the state, but like them, pointing always towards the moraine.

In conclusion, the author reviewed the more important facts discovered during his exploration of the line of the moraine, dwelling upon the character of the moraine where crossing river valleys, the absence of proof of any tongues of ice down such valleys, the absence of glacial drift south of the moraine, the very slight erosion caused by the passage of the glacier, and especially upon the deflections, large and small, in the line of the moraine, which were inexplicable on any other hypothesis than that the moraine now described was pushed out at the foot of a continuous ice-sheet of immense extent.

THE SILICIFIED STUMPS OF COLORADO. By ROBT. B. WARDER, of North Bend, Ohio.

[ABSTRACT.]

A GROVE of well preserved Sequoia Stumps at Florissant, Colo., about twenty-five kilometers W. N. W. of the summit of Pike's Peak, was visited by the author in September, 1872. Red granite abounds; and small outcrops of a trap-like rock are numerous.

Digitized by Google

A small and elevated basin was filled with shales and sandstones, which are still horizontal. Some strata abound in impressions of leaves, similar to the pine, oak, beech, and willow. The prevailing appearance resembles specimens from the Oeningen beds of Switzerland, exhibited in the Museum of Comparative Zoölogy at Cambridge. Some reed-like plants and fish were also found.

Twin Creeks (small tributaries of the South Platte river) have cut through this deposit, to the depth of ten meters or more, exposing the stumps.

The annual rings and medullary rays are well marked. Exposed surfaces are bleached; but many specimens are of a rich chestnut brown, or black, with every appearance of recent wood. The growths of a single year vary much in thickness; the extremes noted were about 1 mm., and 20 or 25 mm. The character of the grain varies much in different trees; sometimes it is straight, sometimes like curled maple, sometimes waved with beautiful regularity. No limbs could be distinguished; but there seemed to be gnarled roots, where the fibres were much confused. In some pieces, the fibres are bent nearly to a right angle, without being broken; in others, the jagged edge looks like brittle wood.

A singular coal-black mass, locally known as the "Carpenter Shop," seemed to be a sort of breccia of portions from 1 to 10 cm. in length, all closely united, with the fibre running in all directions. A few of the stumps are more completely altered, with subvitreous lustre, and red or dull yellow color. One of the least altered specimens lost five per cent of its weight on ignition, including water with a trace of organic matter. Chalcedony and drusy quartz crystals also occur. The former, if in botryoidal or mammillary forms, is commonly called "petrified gum."

These trees, including a specimen five or six meters in diameter, would indicate a milder climate than the present, for frosts are now common as early as September. The endogenous fossil wood found near Denver also supports this conclusion. Hot silicious springs may once have flowed from the volcanic rock; a process of silicification, now in operation on the Yellowstone, is described in Hayden's Report for 1871; but in the Colorado stumps the operation seems to have been far slower and more complete.

Digitized by Google

The Change of Relative Level of the Ocean and the Uplands on the Eastern Coast of North America. By George H. Cook, of New Brunswick, N. J.

[ABSTRACT.]

At a former meeting of this Association, in this place, in 1857, I read a paper upon this subject. My object in again bringing it forward is to call further attention to it — to the kind of evidence upon which it rests, to the effects of this change and to the means of controlling its injurious consequences.

1. Submerged forests furnish the most common and widespread evidence of this change. William Bartram in his "Travels through North and South Carolina, Georgia, East and West Florida," etc., in 1773, says: "It seems evident, even to demonstration, that those salt marshes adjoining the coast of the main and the reedy and grassy islands and marshes in the rivers, which are now overflowed at every tide, were formerly high swamps of firm land, affording forests of cypress, tupelo, magnolia grandiflora, oak, ash, sweet bay and other timber trees, the same as are now growing on the river swamps, whose surface is two feet or more above the spring tides that flow at this day; and it is plainly to be seen by every planter along the coast of Carolina, Georgia and Florida to the Mississippi when they bank in these grassy tide marshes for cultivation, that they cannot sink their drains above three or four feet below the surface before they come to strata of cypress stumps and other trees as close together as they now grow in the swamps." Lyell, in his second visit to the United States in 1845, writes of the coast of Georgia at the mouth of the Altamaha: "As we approached the sea and the brackish water, the wood bordering the river began first to grow dwarfish, and then, lowering suddenly, to give place entirely to reeds; but still we saw the buried stumps and stools of the cypress and pine continuing to show themselves in every section of the bank, maintaining the upright position in which they originally grew. The occurrence of these in the salt marshes clearly demonstrates that trees once flourished where they would now be immediately killed by the salt water. There must have been a change in the relative level of land and sea, to account for their growth, since, even above the commencement of the brackish water, similar stumps are visible at a lower level than the

Digitized by Google

present high tide, and covered by layers of sedimentary matter, on which tall cypresses and other trees are now standing."

On the coast of South Carolina, Professor Tuomey, in his Geology of the State, 1846, records similar facts regarding submerged forests, though he does not think their occurrence indicates any subsidence of the land. He acknowledges that Mr. Lyell has examined the coast of South Carolina and Georgia, and has come to the conclusion that these submerged stumps "show a vertical depression of the land to the amount of at least four feet." In North Carolina Dr. Emmons records the occurrence of submerged forests, in Albemarle Sound. In Virginia, along the shores of Chesapeake Bay, timber is found in the place of its growth, but several feet below the level of tide water, as I am informed by my friend, General R. D. Cutts, of the United States Coast and Geodetic Survey.

The coast of New Jersey is marked by the occurrence of timber and stumps below the present tide level in the marshes which border the State for much of the distance from the head of Delaware Bay to Cape May, and from the last named place to the mouth of the Hudson. In some of these marshes the timber is of white cedar, and has grown in the swamps and soft earth—notably so in the cedar swamps of Dennisville, Cape May County, and in the marsh along the Pennsylvania Railroad between Newark and Jersey City. But there are very many places where oak, maple, gum, yellow pine and other trees of upland growth are found. They are not on the parts of the marsh which are exposed to the action of the sea, but they are still covered by the marsh earth, which must have quietly and gradually advanced and inclosed them, and their stumps and roots are still sound and firm in the solid earth in which they grew. Examples can be seen in the meadows on Delaware Bay, below Salem—in many of the ditches in the marsh near the upland, which have been cut by farmers, everywhere—and a very marked example is to be seen in the yellow pine stumps, in the banks of the canal which connects South River at Washington, N. J., with the Raritan. (Reports Geol. Surv. N. J., and Amer. Jour. Sci., 2d Ser., vol. 24, p. 341.)

On Long Island, in New York, submerged forests occur under the same circumstances as in the marshes farther south. In *The Popular Science Monthly*, vol. 10, p. 434, E. Lewis, jr., records the

Digitized by Google

occurrence of timber and stumps in the salt marshes at Islip, at Tiana Bay, Peconic Bay, Montauk Point, and Fort Hamilton.

In Massachusetts, Professor Hitchcock, in the Geology of that State, p. 307, under the head of "Submarine Forests," says "they consist of the remains of ancient forests now submerged a few feet below the sea, though sometimes laid bare at low water. . . . . In the Harbor of Nantucket, as I am informed by Lieutenant Jonathan Prescott, portions of cedar, maple, oak and beech trees, some of them in an erect position and accompanied by peat of an imperfect character, were found. All the wood except the cedar, which was nearly as sound as ever, was very much decayed. They were buried by four feet of sand, and were about eight feet below low-water mark.

"Another submarine forest exists at Holmes's Hole, on Martha's Vineyard. It is on the west side of the harbor and was described by the pilot as having the appearance of a marsh at low water. Stumps have been found there in considerable quantity; of the cedar at least. Near the southwest extremity of the Vineyard, on the north shore, I was informed that another forest of a similar description may be seen. On the north side of Cape Cod, also, opposite Yarmouth, cedar stumps may be found (as I was informed by the captain of the Falmouth Packet), extending more than three miles into Barnstable Bay. And Henry Wilder, of Lancaster, who first directed my attention to this subject, says that the same thing occurs in the bay of Provincetown, on the side opposite the village. Further inquiries will no doubt bring to light other instances of a similar character; for my opportunities of observation on this subject have been but few."

In the "Geology of New Hampshire," by Professor C. T. Jackson, p. 280, J. L. Hayes, of Portsmouth, mentions that at Rye Beach "among the curious phenomena which may be witnessed, are the remains of a submerged forest. The stumps and roots of trees of a large size are frequently seen during very low water, on the lower margin of the beach. They appear to have been broken off near the roots, which remain in their original positions. The trees were mostly white cedar. . . . Stumps of trees are found in most of the salt marshes around Portsmouth."

In a paper on the Geology of Portland, Me., by Professor Edward Hitchcock and J. L. Hayes (Boston Journal Natural History,

Digitized by Google

vol. 1, p. 338), similar circumstances in regard to submerged forests are mentioned.

In the Acadian Geology of Principal Dawson, page 28, is described a submerged forest at the head of the Bay of Fundy, near Fort Lawrence. He says: "At the distance of 326 paces from the abrupt edge of the marsh, and about 25 feet below the level of the highest tides, which here rise in all about 40 feet, I saw the first of the rooted stumps, which appear in a belt of sand, gravel and stones mixed with mud, which intervenes between the slope of mud already mentioned and the level of low tide. Beyond the stump first seen, and extending to a depth of at least thirty to thirty-five feet below the level of high tide, other stumps were irregularly scattered as in an open wood. The lowest stump seen was 135 paces beyond the first; and between it and the water level there was a space of 170 paces without stumps, but with scattered fragments of roots and trunks, which may have belonged to rooted trees broken up and swept away by the ice.

"On digging under and around some of the stumps, they were found to be rooted in a soil having all the characters of forest soil. In one place it was a reddish, sandy loam, like the ordinary upland of Fort Lawrence; in another place it was a black vegetable soil resting on a white sandy subsoil. Immediately over the soil were the remains of a layer of tough bluish clay, with a few vegetable fibres, apparently rootlets of grasses, which seemed to have been the first layer of marsh mud deposited over the upland soil. All the rootlets of the stumps were entire and covered with their bark, and the appearances were perfectly conclusive as to their being in the place of their growth.

"Of thirty or forty stumps which I examined, the greater number were pine (*Pinus strobus*), but a few were beech (*Fagus ferruginea*), and it is worthy of note that these are trees characteristic rather of dry upland than of lower swampy ground. The pine stumps were quite sound, though somewhat softened and discolored at the surface. The beech, on the other hand, though retaining much of the appearance of sound wood in the interior, was quite charred at the surface, and was throughout so soft and brittle that large trunks and roots could be cut through with a spade or broken with a slight blow. Owing to their softness the beech stumps were worn down almost to the level of the mud, while some of the pines projected more than a foot; even these last were, however, much

Digitized by Google

crushed by the presence of the ice, which, with the tides, must eventually remove them. The largest stump observed was a pine two feet six inches in diameter and showing more than two hundred annual rings of growth. I was informed by respectable and intelligent persons that similar appearances have been observed on the opposite side of the La Planche, and in various other places in the Cumberland Basin. It is only, however, in places where the marsh is being cut away by the current that they can be seen, and the stumps, when laid bare, are soon removed by the ice. Similar beds of stumps and vegetable soil are also occasionally disclosed in digging ditches in the shallower parts of the marshes, and there appears little reason to doubt that the whole of the Cumberland marshes rest on the old upland surfaces."

The west coast of Greenland from about latitude 60° 43′ N. to Disco Bay near latitude 69°, appears from various signs and traditions to have been subsiding for the last four centuries. Ancient buildings on low, rocky islands, and on the shore of the main land, have been gradually submerged, and experience has taught the aboriginal Greenlander never to build his hut near the water's edge. The Moravian settlers have been obliged, more than once, to move inland the poles upon which their large boats were set, and the old poles still remain beneath the water as silent witnesses of the change. (Lyell's 'Principles of Geology.) The evidence in this case, however, is much more like that to be brought forward under the second kind of proofs of change of level.

2. Artificial structures and works of men furnish other evidence regarding this change of level. At Southampton, on Long Island, the first settlement was made by the English in 1640, and the land was laid out in farms and fields before 1650. One of the fields near the seashore and a little west of the village pond was fenced in at that early day. The fence posts must have been set in the meadow sod immediately behind the beach. All traces of this fence were lost sight of till within a few years, the sand beach having been driven inward so as to bury it entirely. But now after long and violent storms, which waste away the sand on the flat or storm beaches, the old posts and the meadows in which they were set are washed clean, and they are seen on the outside of the beaches, and near low-water mark. The meadow sod is still tough and firm, and the tracks of cattle and horses show as

Digitized by Google

plainly in it as they did when they were made, which was two hundred or more years ago. In that time the sand beach was moved inward its whole breadth or more, and the surface of that time has gone down several feet. The flat sands made by storm-tides are two or three feet above ordinary high water, and the several intelligent gentlemen, residents of Southampton, whom I met, and who had seen them at different times, judged that they were now covered with from four to seven feet of sand. Should another opportunity present, I am in hopes this change of level can be ascertained accurately.

The first settlement near Barnegat, N. J., was made as early as 1690; farms were cultivated on the fertile soils where they first located. They were only a few feet above the level of the salt meadows, which bordered them, and which are always at the level of ordinary high water. The first settlement, which really occupied the best of the soil, has long since been abandoned. The ground is now overgrown with salt grass, and the corn rows in which the fields were last cultivated can just be distinguished. The change of level here cannot be less than two feet, and it may be much more than that.

On the beach at the seaside about five miles below Barnegat inlet, there were settlements made by whale-fishers as early as 1690, and they had houses built, and kept animals on the beach and the adjoining salt meadows. There was also a timber swamp extending along on the inside of the beach for two miles or more. The settlement was long since abandoned, the sand of the beaches has been moved inward several hundred yards, the timber in the swamp is nearly all killed, and the stumps of the trees are some of them still to be seen standing in the flat storm-tide beach. On digging down to find whether they were in their original places of growth, I found them still in the swamp earth, with the bark and fibrous roots attached, and that the surface of the swamp earth was fully three feet below the level of the sand which embedded them, and as low as if not lower than ordinary high water — quite too low for cedar trees to grow now. Two or three persons who have been long familiar with the beach assure me that, for a long distance there, there is salt meadow sod to be seen projecting out on the strand and near low-water mark, — and on this they have seen the tracks of horses, cattle and sheep distinctly marked. These are only exposed after long and violent storms which waste off the

Digitized by Google

sand and carry it out to sea.[1] And they are again covered with sand when the waves are less powerful and the roll of the ocean brings back the sand and piles it in the flat and steeper-sloped strand of common tides. Tracks would be covered and preserved by the wash of the ocean through glades or low parts of the beach, which would carry forward the sand and deposit it on the surface of the meadow, and the wind finally moves the whole body of the broken beach inward. These circumstances certainly indicate a change of level, and a rise of the sea upon the land within the past two hundred years.

The land on the eastern shore of Delaware bay was taken up, and settlements begun as early as 1650. In the early years succeeding islands of hard and timbered ground in the meadows were cleared and farm buildings erected on them, and the farms were cultivated for many years. Now these islands are covered with water in high tides and only marsh grass is grown upon them. This, too, indicates a vertical rise of the tide-water upon the upland, to the extent of a few feet within two hundred years past.

The consequences of this change in level are to be seen everywhere along the seashore, in its rapid and continuous wearing away by the action of the waves. From Florida to Greenland, as has been mentioned in the former part of this paper, facts recorded show that this is the case. In some instances four hundred or five hundred feet in breadth have been worn from the shore within the last forty years. The wear is so uniform and so consistent too, with the cause, that is, with the change of level, that it does not seem necessary here to cite cases. Another ill effect of the change is that of making the low-lying uplands into tide meadows and marshes. This change is gradual, if they are in wood; the trees die out slowly and no new trees grow — and if it is farm land it becomes less productive from imperfect drainage, the soil is soured, and finally its cultivation is unprofitable. Where the shores are bold these effects are not taken note of at all.

Navigation is improved by this change, the channels must deepen, and the waterways be easier for the passage of vessels — and this to some may be a kind of compensation for the damage which is done to others.

The rapid wear of the shores, and the changes produced by it,

[1] Such a storm occurred in Sept., 1882, and the tracks were found on solid and firm sod, about three feet below mean high-water mark.

Digitized by Google

have made necessary in many cases the construction of expensive works to resist or divert the increased force of the waves. Sandy Hook has grown longer and narrower gradually for the last hundred years, and jetties have been built out on the sea side of the Hook to stop the wearing away of the land and to afford a lodgment for the sand that is moving with the current. The work appears to be successful. Similar plans were made for preventing the wear about the entrance to Charleston Harbor many years ago. Expensive works are projected to prevent the wear of the shore at Long Branch, and the damages there are so heavy that the protection must soon come. The changes about many of the lighthouses on the low seashores are owing to this cause, and the works for their preservation involve a heavy expense every year. When this change is accepted as a settled truth, and engineers study its consequences and effects, in the places where they are shown, then the proper works for obviating them can be best devised.

It becomes an interesting subject of inquiry as to the cause of this change of level. Facts have not yet been accumulated to a sufficient extent to determine whether this change is local or general throughout the northern hemisphere. At present I am led to look upon it as general. The noted case of subsidence in southern Sweden, which is referred to in all our text books on geology, is of the same kind with those in our own continent.

In Scania, the most southerly part of Sweden, the seaport towns bear evidence that the land is there sinking. Streets originally built above high-water mark are now below it, and even old streets are found at a still lower level, showing that the subsidence has been in progress for a considerable time. A stone, the position of which had been exactly fixed by Linnæus, in 1749, was found in 1836 to be one hundred feet nearer the water's edge than it was eighty-seven years before."—Jukes, p. 332. Lyell, in his "Principles of Geology," gives a long list of cases on the coasts of England, Scotland, France, Holland, and along the Baltic, where the action of the sea is the same as on our coasts, and he gives also numerous cases of submerged forests similar to ours and occurring below the present tide level.

There has been considerable doubt thrown upon the fact of a general subsidence such as is here described, on account of the occurrence of sea-shells and buried timber, both of kinds now living,

Digitized by Google

in earthy deposits which are a few feet above the present sea-level. Such cases do occur. I have observed them in New Jersey, and they are described by others as occurring in other places along the American sea-coast. But, however recent they may be, they belong to a period which preceded the present one of depression. The wood which is found is none of it so fresh as to be fit for timber or lumber as that of the present depression is, and the occurrence of the shells is more in alluvial sand or mud beds than any that is forming now, and the shells themselves, though of the species still living in the adjacent waters, appear a little different from the recent ones. The present depression may not have been going on more than 500 or 1000 years, and the indications are that there has been another period of depression in which the surface of the upland was ten feet or more nearer the sea-level than it now is. A single instance will illustrate this statement. The Maurice River is a tidal stream which empties into Delaware Bay. About fifteen miles above its mouth the river has cut into its eastern bank so as to expose an ancient oyster-bed, with its mass of undisturbed shells, still in pairs and all in their natural position. This bed is fully eight feet above ordinary high-water mark, and yet there is every indication that it has never undergone any disturbance except in the gradual elevation which brought it above the tide level, and is now lowering it again to its original place beneath the waters.

A careful study of the numerous cases like this will satisfactorily prove that there have been other periods of alternate depression and elevation in comparatively recent times, the phenomena of which are so nearly alike that they are very commonly confounded with each other. And when they are clearly distinguished, it will probably be found that the rise or the depression is one common to our whole coast and probably to the whole northern hemisphere. An accumulation of ice in the northern polar regions would be sufficient to move the centre of gravity of the earth in that direction, and thus to cause an increased amount of water in that hemisphere, and of course disturbance of the relative level of the ocean and uplands, and the apparent subsidence of the land.

Digitized by Google

On the Classification and Origin of Joint Structures. By W. O. Crosby, of Boston, Mass.

[ABSTRACT.]

This paper is, in a large measure, an outgrowth of the articles by Mr. Gilbert and Prof. LeConte in the American Journal of Science for January, March and July, of the current year. I fully agree with Mr. Gilbert, that parallel jointing must be quite distinct in its origin, as it usually is in its characteristics, from both shrinkage cracks and slaty cleavage. Nevertheless, I cannot follow him in so restricting the definition of joint structure as to exclude shrinkage cracks, chiefly because such a classification appears impracticable. A very large proportion of the planes of division in both stratified and eruptive rocks are due to shrinkage, as is clearly recognized by all in the columnar jointing of basalt, and it is often impossible to distinguish the shrinkage cracks from those produced by other causes. Hence, if Mr. Gilbert's classification were adopted, it would be necessary to coin a new term to be used, in the very numerous cases where the origin of the planes of division can be determined. It seems better, therefore, to class shrinkage cracks as joints, and then to distinguish, where we can, between joints having unlike origins.

Broadening the definition of joint structure in the way here proposed, we are obliged to recognize at least three distinct classes of joints. These are, first, the short, non-parallel and non-intersecting joints dividing the rocks into irregular polygonal blocks and having their origin, as all geologists agree, in the contraction of the rocks, and hence properly called contraction or shrinkage joints; second, the joints near, and parallel with, the surface in granitic rocks, which have been satisfactorily explained by Prof. Shaler, as due to the expansion of the surface under the influence of the sun's heat, and which may, therefore, be appropriately named expansion joints. The third and most important class embraces the straight, parallel and intersecting joints. These have been attributed to shrinkage, compression, magnetism and an unexplained shearing force. The writer concurs with Mr. Gilbert in rejecting all these hypotheses, and advances the idea that earthquakes are the principal cause of parallel jointing.

Digitized by Google

An earthquake is a series of spherical elastic waves, the normal velocity of which, in solid crystalline rocks, as shown by the progress of slight tremors and sound, is 10,000 to 12,000 feet per second. But it has also been demonstrated by observation that the actual average velocity of important shocks is only about one-eighth as great, or, 1,200 to 1,600 feet per second. The generally accepted explanation of this enormous difference is that the high waves of the severe shock break the rocks, which are at best but imperfectly elastic, at every step, and are greatly retarded in consequence, while the low waves, passing successfully without rupture, run with the normal velocity of the medium. All parts of the earth's crust are affected by earthquakes, and since all important vibrations break the rocks which they traverse, the conclusion follows irresistibly that all geological formations (except, perhaps, the most recent, which are precisely those freest from joint structure) must be much broken by this agency. The question arises, then, where are these earthquake fractures? For obvious reasons, they cannot be regarded as cleavage planes; and the only alternative is to call them joints. Joints possess the required character of universality; but the earthquake fractures are clearly not contraction or expansion joints; and so we are driven to the conclusion that earthquakes are a principal cause of ordinary or parallel joints.

Earthquake fractures are necessarily parallel to the wave surface, or normal to the line of propagation. Therefore, they must be parallel to each other and usually appproximately vertical; agreeing exactly in these respects with parallel joints. Earthquake foci are usually situated along certain definite lines in the earth's crust, either lines of volcanic activity or of upheaval, plication and faulting. Hence it is reasonable to expect considerable constancy in the directions of earthquake movements and of earthquake fractures in limited districts, thus affording another close agreement with parallel jointing. Fractures produced by earthquakes moving in different directions must cross each other without interference, precisely as do the joints in different sets. Apparently, there is no important characteristic of parallel jointing which is not satisfactorily explained by a reference to earthquakes as a cause.

Elevation and plication must also be accompanied by fractures

Digitized by Google

now and then; and these, it is easy to see, will be parallel, and will intersect without interference, when the strains are varied in direction. But earthquakes account for joints in rocks of all classes and conditions, in the unconsolidated and undisturbed Post-tertiary clays as well as in the ancient, crystalline and contorted gneisses, while the normal accompaniment of compression and plication is cleavage, and not jointing; although neither structure can be developed by these agencies without disturbing the stratification. Earthquakes are contrasted with all the other agencies referred to by their almost instantaneous action; and this peculiarity enables us to explain the remarkably regular jointing of some very coarse and irregular conglomerates; for these rocks break very irregularly, unless the force is applied with great suddenness.

I have elsewhere[1] pointed out that the irregular and ragged outlines usually exhibited by masses of coarsely crystalline eruptive rocks require us to believe that the joint structure does not extend to great depths, but is essentially a superficial feature of the earth's crust. And I have also shown that this view is perfectly consistent with the hypothesis that shrinkage is the chief cause of jointing.

My purpose now is to prove that the argument for the superficial nature of joint structure is strengthened, rather than weakened, when we substitute earthquakes for shrinkage as the principal cause of jointing. It is a well established fact that earthquake-foci are, in the main, comparatively superficial, and also that the rocks composing the earth's crust are much less solid and coherent, that is, much less elastic, near the surface than at great depths. But the number and extent of the fractures produced by an earthquake are inversely proportional to the elasticity of the rocks which it traverses; and just as certainly as the elasticity increases downward, the fractures (joints) must increase upward.

Hence, in conclusion, we may safely say that every theory of the origin of joint structure now entertained by geologists (and in a certain sense they are all true, some explaining one kind of jointing and some another) is consistent with the view that jointing is a superficial structure, the deep-seated rocks being essentially unjointed.

[1]Geological Magazine for Sept., 1881.

Digitized by Google

The Undulations of the Rock-masses across Central New York State. By Henry S. Williams, of Ithaca, N. Y.

[ABSTRACT.]

Examination of the dip of the rocks exposed in the counties of Chemung, Tioga, Tompkins, Schuyler, Seneca, Cayuga and Ontario has revealed a series of nearly parallel folds trending about twenty to thirty degrees north of east, decreasing in strength from the Pennsylvania line toward the northwest.

A north and south line from Ithaca, N. Y., to Ulster, Pa., shows the following folds:

About five miles south of Cayuga lake is the axis of a syncline, quickly rising into an anticline which crosses the Lehigh valley railroad just south of Newfield Station.

A second syncline crosses the same road between West Danby and Spencer stations, and the U. I. and E. R. R. between Swartwood and Van Ettenville. This seems to be the continuation of the Cowanesque syncline of the Pennsylvania survey, which is seen farther east, at Marathon in Cortland county, N. Y.

Near Van Ettenville there are evidences of a slight syncline in the top of the main anticline. The third syncline crosses the Lehigh valley road between Bingham's and East Waverly. The southern slope of this syncline, with northwesterly dip, appears at Chemung, Chemung Narrows, Waverly and the northern suburbs of Owego.

This is doubtless the continuation of Sherwood's Crooked creek syncline of the Pennsylvania survey.

From Ithaca going northward, the first syncline crosses Cayuga lake near Ludlowville, and Seneca lake at North Hector.

Slight folds are seen along both Seneca and Cayuga lakes farther north, but too slight to determine their axes with precision. The most northern anticline detected is near the foot of Canandaigua lake on the west side.

North of the Pennsylvania line the greatest dip is rarely more than three degrees.

The dips to the northwest are shorter and steeper than those in the opposite direction.

The folds are about twelve miles apart.

Digitized by Google

Occurrence of Magnetic ore deposits in Victoria County, Ontario. By W. Hamilton Merritt, of Toronto, Canada.

[ABSTRACT.]

In going north from Lindsay, the primary rocks are met with, between Fetty's Bridge and Kinmount.

They here consist of granite, gneiss, syenite and crystalline limestone, with occasional bands of dioritic rocks; the latter are not so strongly developed here as farther east in the Madoc region.

There is a small amount of Labradorite rock or norite, which, however, has been observed at only one place.

Some thirteen deposits of magnetic ore have been located in this Victoria region, the most important of which were visited by me last year; there are numerous other untested occurrences. The ore bodies occur, as is usual with magnetic iron ore deposits, in beds more or less lenticular and of size varying from mere patches to beds of from 40 to 50 ft. in width, and unproved length and depth, enclosed in and running with the country rock.

It is difficult in some cases to discover defined walls, as a layer of rock often comes in between two deposits of ore, or between the main body and a smaller one; and again in other cases there is a complete gradation from the one to the other. Crystalline limestone almost invariably in this district is associated with the magnetic ore deposits, which either occur in it or near its junction, with granitic or hornblendic rocks. Therefore in searching for iron ores in this region, it is well to keep in the vicinity of the bands of crystalline limestone. The ore body at the Paxton mine, though occurring in a syenitic gneiss, is associated with a thin band of crystalline limestone.

Hornblende is very intimately connected with the magnetic ore, and, especially at the above mentioned Paxton mine, one gives way to the other sometimes insensibly and again very abruptly throughout the extent of the workings.

Besides calcite and hornblende, other minerals such as augite, felspar, mica, iron pyrites, quartz and also specimens of olivine and serpentine were found occurring with the ores.

The magnetic ores of this district contain as a rule merely traces of phosphorus, but most of them require calcining to drive

Digitized by Google

off the sulphur, though some, such as the Paxton ore, are almost entirely free from pyrites. Titanium is as a rule not present in a greater quantity than mere traces, though some deposits such as at Pine Lake carry a notable quantity. The metallic iron in the ore as it comes from the mine averages between 48 and 49 per cent and the selected has about 60 per cent iron.

The beds here, as in other well known localities, occur in defined belts, as for example a belt can be followed from lot 20 in the first concession of Snowdon to lot 30 in the fifth concession and probably farther.

The magnetic ore deposits of the Victoria region considered apart from any others, from their strike and dip with the rocks of the country, their similar crystalline character, their frequent insensible gradation of rock to the ore, and *vice versa*, and the similarity of their intercalated minerals, it would appear inevitable that they had been deposited with the rocks that contained them; either, according to Dr. T. Sterry Hunt, while during the eozoic times chemical activities, dependent upon greater subterranean temperature, different atmospheric conditions and abundance of thermal waters were at work, and therefore we might suppose local deposits of a varied character were going on; or, the neptunean view as ordinarily expounded, with its subsequent metamorphosis.

In the Geological Survey Report for Canada for 1873–74, Dr. Harrington shows how by heat the conversion of a bog ore was effected to a magnetite, having all the characteristics indicated by the name. As deposits of the lake bog ore are taking place at this present day in a manner which would seem to answer all requirements (with subsequent metamorphosis) for the formation of these magnetic ore beds, it seems natural that this theory finds many supporters.

The first developed deposit in this region, known as the Victoria or Old Snowdon mine, occurs in a wide band of crystalline limestone to the east of Kinmount. This ore bed is perhaps the most interesting in Victoria County, owing to its apparent strike, where opened, at an angle of nearly 45° to the general strike of the rocks of the country. It would seem, therefore, in contrast to all other deposits discovered in this region, to have been subsequently deposited in a fissure. The irregularity in the strike of this deposit may, however, when the country can be more thoroughly examined, be found to have been caused by a fault running the length of the

Digitized by Google

valley, at the edge of which the deposit in question is being worked, for there is evidence of much disturbance where the rocks have been exposed.

The Victoria Railroad runs through this district and as large quantities of timber suitable for the manufacture of charcoal are in the vicinity, there is not a more favorably situated locality for charcoal iron smelting in America, and there will undoubtedly be important developments in this direction.

Comparative View of the successive Palæozoic Floras of Canada. By J. W. Dawson, of Montreal, Canada.

[ABSTRACT.]

In Canada, we possess a very complete series of fossil plants extending from the Upper Silurian age to the Permian, and the object of the paper is to sketch out the characteristics of the several floras and sub-floras which have been studied.

I. *Carboniferous Flora.*

This presents three sub-floras in descending order: (1) That of the *Permo-Carboniferous* or Lower Permian, more especially seen in eastern Nova Scotia. It contains several common Carboniferous species, as *Dadoxylon materiarium*, *Pecopteris arborescens* and *Calamites suckovii*, associated with species peculiar to itself, as *Walchia robusta*, *W. gracilis*, *Calamites gigas* and *Cordaites simplex*. (2) That of the *Coal Formation*, which is the great headquarters of the Carboniferous flora, and is especially rich in *Sigillaria* and its allies, and in ferns. One hundred and thirty-five species of plants have been catalogued from this formation. There are nineteen species of *Sigillaria*, about the same number of *Lepidodendron* and allied genera, fifty ferns and thirteen *calamites* and allied forms. (3) The *Millstone Grit* sub-flora. Here we have a limited number of species, precursors of those of the coal measures, and described in a special report of the author published by the Geological Survey of Canada. *Dadoxylon Acadianum* is a very characteristic conifer of this period. (4) The *Lower Carboniferous* sub-flora. The number of species here is small and many of them peculiar, this formation being separated by

Digitized by Google

the marine limestones from the Millstone Grit, and on the other hand being unconformable to the Erian or Devonian below. *Dadoxylon antiquius* is a characteristic pine of the period, and *Lepidodendron corrugatum* and *Aneimites Acadica* are very common.

II. *Erian Flora.*

Here we have three sub-floras, all markedly distinct from those of the Carboniferous. (1) The *Upper Erian* sub-flora is characterized more especially by ferns of the genera *Archæopteris* and *Cyclopteris*. *A. Jacksoni*, *A. gaspiensis* and *C. obtusa* are very abundant forms. The flora is similar to that of the Catskill of New York and the Kiltorcan beds in Ireland. (2) The Middle Erian sub-flora, corresponding to that of the Hamilton and Chemung groups in New York, is very rich in species. It contains several coniferous trees of the genus *Dadoxylon* and a great number of beautiful and delicate fern fronds, including sphenopterids and *Hymenophyllites*, as well as such ferns as *Megalopteris*, *Cyclopteris* and *Archæopteris*. *Lepidodendron Gaspianum* is very characteristic, and there are species of *Psilophyton*. *Sigillaria* scarcely appears, but there is an abundance of *Cordaites* (*C. Robbii*). The remarkable aquatic plants of the genus *Ptilophyton* occur here, and there are beds filled with Macrospores or "*Sporangites*." (3) The Lower Erian sub-flora, which is specially characterized by the genera *Prototaxites*, *Arthrostigma* and *Psilophyton*. These plants are often very abundant, but belong to few species.

III. *The Upper Silurian Flora.*

This is limited in Canada to *Prototaxites*, *Psilophyton* and the rounded fruits of the genus *Ætheotesta*, equivalent to *Pachytheca* of Hooker. These occur in rocks attributed to the Lower Helderberg group, and no undoubted land plant has been found in any older formation.

The above mentioned sub-floras can be readily recognized by a competent palæobotanist; and, as the author has shown in reports published by the Geological Survey of Canada,[1] can be correlated with those of the United States and Europe; but any more minute subdivisions are of merely local value.

[1] Report on Erian or Devonian and Upper Silurian Plants of Canada, 1871. Report on Plants of the Lower Carboniferous and Millstone Grit, 1873. Report on Erian or Devonian Plants of Canada, Part II, 1882.

Digitized by Google

On the Origin of Joint Cracks. By H. F. Walling, of Washington, D. C.

[ABSTRACT.]

Mr. G. K. Gilbert, of the U. S. Geological Survey,[1] has observed in recent and nearly undisturbed clay beds of the former "Lake Bonneville" in Utah, a jointed structure in two directions nearly at right angles with each other. In this case, as he remarks, it is difficult to conceive that powerful compressive forces have been exerted in directions normal to those of the joint planes, thereby producing the jointed structure in a manner similar to that by which slaty cleavage is supposed to have been caused.

Nor does Mr. Gilbert accept the explanation offered by President Le Conte,[2] who, having observed shrinkage cracks in some recent alluvial deposits of California, attributes jointed structure to a similar process of contraction. Shrinkage of strata held by adhesion to their supporting beds, produces a prismatic structure in which the planes of separation are seldom continuous beyond the individual prisms. In jointed structure, on the contrary, the planes of separation are continuous, those of different systems intersecting each other but exhibiting no mutual relations. Regarding the reference to magnetic or to shearing forces for the production of jointed structure as unworthy of consideration, Mr. Gilbert considers the problem an open one.

It is clear that the force which has produced parallel joint cracks must have a definite direction over the wide areas where the parallelism prevails. It seems probable, moreover, that it must have acted with a suddenness, differing from the steady, long continued strains which slowly bend the strata into curved folds. Such a force is supposed by the writer to come into action when sufficiently powerful earthquake waves attend the production of faults.

Assuming that the materials of which the earth's interior are composed are in a sufficiently plastic condition, at least near the surface, to maintain a general equilibrium of pressures, it is evident that when this equilibrium is disturbed by the transfer of

[1] Am. Jour. Sci., Vol. XXIII, June, 1882, and Vol. XXIV, July, 1882.
[2] Am. Jour. Sci., Vol. XXIII, March, 1882.

Digitized by Google

materials from continents to ocean floors, the inequalities of pressure will tend to move the more plastic substratum which supports the overloaded ocean beds to positions under the lightened continents. The sinking of ocean beds and rising of continents will bend and sometimes fracture the more rigid crust above. Fractures or faults produced in this way will be longitudinal or in the general direction of the axis of denudation, and since the corrugation or folding of strata is normal to the subterranean return flow of plastic material which produces it,[3] by gradually diminishing the width of the belts supporting the upper strata, the axes of denudation and corrugation will be in the same general direction.

The sudden sinking, at the time of fracture, on one side of the fault and rising on the other, originates an earthquake, which is a wave movement outward from the point, or in this case *line*, of disturbance. On and near the surface the wave movement becomes not only a succession of rarefactions and condensations, but a progressive, up and down movement like that of ocean waves. The actual amount of bending in cases of exceptionally powerful earthquakes has sometimes been so great as to cause the ground to visibly open and shut in fissures, sometimes even engulfing and closing in upon men and animals.

Here then we have a sudden wave force, competent to rupture brittle and inextensible materials like rocky strata and clay beds in lines or planes parallel to its origin. Moreover, the sinking on one side and the elevation on the other would be likely, while the originating cause continues in action, to augment from time, especially in the portions of the fault midway between its ends. This would give rise to lateral or transverse bendings and fractures with accompanying transverse waves. In this way two sets of joint cracks nearly at right angles to each other might occur.

[3] See Proceedings Am. Assoc. for the Adv. of Science, St. Louis meeting, 1878, p. 179.

Digitized by Google

ON THE ASSOCIATION OF CRYSTALS OF QUARTZ AND CALCITE IN PARALLEL POSITION. By R. B. HARE, of Guelph, Ontario, Canada.

[ABSTRACT.]

THE association of crystals of quartz and calcite in parallel position will be illustrated by specimens taken from the Grube "Reicher Trost," Reichenstein, Silesia, Germany. The specimens show the almost perfect similarity of the Reichensteiner and Schneeberger occurrence and defend Eck of Berlin, against von Rath and Frenzel.

TITLES OF OTHER PAPERS READ IN SECTION E.

THE EOZOIC ROCKS OF CENTRAL AND SOUTHERN EUROPE. By T. Sterry Hunt of Montreal, Canada.

THE SERPENTINES OF ITALY. By T. Sterry Hunt of Montreal, Canada.

NOTE UPON THE GENUS PLUMALITES. By James Hall of Albany, N. Y.

ON THE RELATIONS OF DICTYOPHYTON, PHRAGMODICTYUM AND SIMILAR FORMS WITH UPHANTAENIA. By James Hall of Albany, N. Y.

THE FELSYTE-TUFA OF COLORADO. By Alexis A. Julien of New York, N. Y.

THE DUNYTE BEDS OF NORTH CAROLINA.[1] By Alexis A. Julien of New York, N. Y.

THE GENESIS OF THE CRYSTALLINE IRON ORES OF NORTH CAROLINA AND NORTHERN MICHIGAN.[2] By Alexis A. Julien of New York, N. Y.

[1] Published in full in the Proceedings of the Boston Society of Natural History, 1883.
[2] Published in the Proceedings of the Philadelphia Academy of Natural Sciences, 1882.

Digitized by Google

THE COMPARATIVE STRATIGRAPHY OF THE CRYSTALLINE ROCKS OF NORTH CAROLINA AND CANADA. By Alexis A. Julien of New York, N. Y.

ARCTIC EXPLORATIONS IN NORTH AMERICA. By John Rae of London, England.

THE TOPOGRAPHY AND GEOLOGY OF THE GREAT SALT LAKE VALLEY. By William Bross of Chicago, Ill.

NOTE ON THE FAUNA OF THE CATSKILL RED SANDSTONE. By E. W. Claypole of Yellow Springs, Ohio.

ON AMPHICOELIA CEDARVILLENSIS FROM THE NIAGARA GROUP OF CEDARVILLE, OHIO. By E. W. Claypole of Yellow Springs, Ohio.

NOTE ON THE EXTERIOR MARKINGS OF BARK OF LEPIDODENDRON CHEMUNGENSE. By E. W. Claypole of Yellow Springs, Ohio.

A ROCKING STONE IN NEW YORK CITY. By Chas. Hallett Graham of New York, N. Y.

FRESHWATER LIGNITIC SERIES OF BEDS IN THE CRETACEOUS FORMATION OF FRANCE. By D. W. Kowalevsky of Moscow, Russia.

ON THE SURFACE LIMIT OF THICKNESS OF THE CONTINENTAL GLACIER IN NEW JERSEY AND ADJACENT STATES, WITH NOTES ON GLACIAL PHENOMENA IN THE CATSKILLS. By John C. Smock of New Brunswick, N. J.

SOME MOOTED POINTS IN AMERICAN GEOLOGY. By J. S. Newberry of New York, N. Y.

GENESIS OF NORTH AMERICAN FLORA. By J. S. Newberry of New York, N. Y.

SUGGESTIONS AS TO THE HISTORY OF THE LOWER COAL MEASURES OF OHIO. By Edward Orton of Columbus, Ohio.

THE CAVES OF STAFFA. By F. Cope Whitehouse of New York, N. Y.

Digitized by Google

SECTION F.

BIOLOGY.

Digitized by Google

Digitized by Google

ADDRESS

BY

WILLIAM H. DALL,

VICE PRESIDENT, SECTION F, BIOLOGY.

MEMBERS OF THE SECTION OF BIOLOGY:—

IN compliance with the custom of the Association, your chairman might have made use of this occasion to review the progress for the past year in that department of Biology which is his preferred field of research. Such a review would have had interest chiefly for specialists in Malacology, now, alas! only too few in number, and it has occurred to me that the opportunity might be better utilized in another way. I propose, therefore, to take a brief general review of what has been accomplished in America toward a knowledge of the biology of its mollusks; and, in so doing, to point out certain directions in which the earnest student may find a field ripe for the harvest, and where at present laborers are either wanting altogether or unfortunately few in number. In this way, perhaps I may be able to gain some recruits for this regiment of the scientific army, from among those young and ardent students who have their work, for the most part, still to do, and who have not yet made a choice among the many peaceful and attractive paths which Nature opens to those who would know her and her ways.

The study of mollusks was at first æsthetic rather than scientific, and to this day its popularity is chiefly fostered by the satisfaction of the sense of beauty derived from a contemplation of the exquisite shells produced by some of the members of this branch of the animal kingdom.

Digitized by Google

An almost purely artificial classification for shell-bearing mollusks was invented by the father of Natural History, Linnæus, which could be mastered by the least scientific mind in a few easy lessons. So convenient did this prove for collectors and others who wished merely to index as easily as possible their cabinets of shells, polished and duly marshalled in pairs, that, when Cuvier and the immortal Lamarck reformed the classification and for the first time created a science of Malacology, opposition was decided and long continued. The early students, seeking to know the relations of animals which were huddled in a few heterogeneous genera by Linné, were the subject of no little opprobrium from the conchologists of that day, and were very generally looked upon as dangerous radicals and unsafe guides. The intercourse between the students of various countries was incomparably less in amount and much more expensive than at present, and various naturalists pursued similar studies unknown to each other, whence arose great confusion in nomenclature which has not yet ceased to trouble the student.

In this condition was the science when Thomas Say, the pioneer conchologist of America, began to publish his studies on North American mollusks. The first scientific article on the shells of this country, published here, was the article on Conchology by Say in the American edition of Nicholson's Encyclopædia printed in 1816.

The determination of species is naturally the first requisite in the investigation of a local fauna, and the work of our earlier naturalists was largely descriptive from the necessities of the case and the state of science at the time. Much had been previously done by foreign naturalists but in an unsystematic way, and for a good many years American students were occupied in the description and iconography of our native mollusks as an inevitable preliminary to the study of geographical distribution and other more philosophical branches of the subject. It is unnecessary here to trace, even did space permit of it, the gradual progress in this direction, to which naturalists in all parts of the country contributed.

At present the molluscan fauna of the land and fresh water shells of North America is remarkably well known, only the older parts of Europe presenting a parallel to it. Something still remains to be done in the southern states, especially in the more

Digitized by Google

mountainous portions, but as a whole we can hardly expect that the addition of new species will more than equal in number the reduction in our specific lists, which a greater familiarity with already named forms may render necessary.

With marine forms the case is somewhat different. The fauna of Canada and of the eastern coast of the United States north of the Chesapeake has been worked out with great thoroughness by the energy of resident naturalists, among whom it may not be invidious to mention Say, Lesueur, Gould, Conrad, Mighels, C. B. Adams, Stimpson, Couthouy, Dawson, Whiteaves, Smith and Verrill, as especially eminent. On the western coast where a much richer fauna prevails, the labors of Carpenter, Cooper, Stearns, Gabb, Hemphill and others have given us a pretty complete knowledge of the species from California to Sitka. For the region still farther north, in addition to the labors of Middendorf, large material, in part unpublished, has accumulated in my own hands chiefly through investigations made in person and with the assistance of my companions in explorations in Alaska and on the Arctic coast. With the exception of the Alaskan coast the mollusk-fauna of Arctic America is well known, and new species hardly to be hoped for by the most energetic explorer of the litorale.

The exploration of the southern coast, especially that of the Gulf of California, is much less thorough and indeed from Georgia round the peninsula of Florida to Galveston, there is hardly any locality which would not repay a careful search. Nearly every such attempt results in new discoveries. The question is somewhat complicated by the inchoate state of our knowledge of the West Indies, whence multitudes of marine shells have been described, but in a scattered way and often without (or with an erroneous) statement of habitat. Our knowledge here has not progressed far enough to permit of tenable deductions in regard to geographical distribution and a wide field is open for research.

The study of geographical distribution is one of the most fascinating, far-reaching and important branches of biology. By its help problems of world-wide significance find solution; but it requires a thorough knowledge of the forms involved, a uniformity in the use of nomenclature, and some acquaintance with the palæontology of the later tertiary strata. Without these,

Digitized by Google

sound conclusions cannot be arrived at; and hypotheses, like inverted pyramids, are in perpetual danger of complete overthrow.

In this connection I may refer to a field in which no one is systematically at work and which seems to me to promise rich reward to patient and thorough investigation. Within a comparatively short period many lake basins and fresh water deposits have been explored for mollusks recent and fossil. Among these may be mentioned sundry Dalmatian lakes, Lake Baikal, Lake Tanganyika, the lakes of Nicaragua, the Colorado basin and the Laramie beds of our western territories. I have long wondered at the curious repetitions of form and ornamentation which occur in certain *Unionidæ* or fresh water mussels from Burmah, Pegu, Lake Nicaragua, our western Tertiary beds, and last of all are now reported from Tanganyika. *Camptoceras*, originally described from a living species in India, is now reported fossil in England. *Melanopsis*, now not living nearer than Spain, has lately been discovered by White fossil in the Laramie beds; and, as in New Zealand, associated with a slipper-limpet which appears to belong to the genus *Latia*. *Pyrgulifera* Meek, from the Western Tertiaries, offers no characters by which it may be distinguished from Smith's Tanganyika *Paramelania* more recently described. Several forms described by Neumayr and others, from ancient European lake basins, seem nearly identical with American fluviatile genera. In spite of the opinion of the eminent French editors of the Journal de Conchyliologie (biassed a little I fear by the enormous distance intervening), I can see no valid characters by which the shells of a whole group of living mollusks (*Baikalia*) from Lake Baikal can be distinguished from our fossil *Tryoniæ* of the Colorado basin.

These facts, if confirmed as I think they would be by more thorough comparison and research, must have a deep significance. Who will devote himself to the solution of the problem?

Another line of investigation, closely connected with the geographical distribution of species, has recently been taken up with rich results. I refer to the exploration of the bed of the deep sea. Its relations are American rather from the fact that its initiation began under the auspices of the Coast Survey of the United States, and that its latest methods are largely due to the inventiveness of American naval and Fish Commission officers, than from the results of the work itself, which are world-wide in

Digitized by Google

their application, and to which various nations, especially the English, have contributed in no stinted measure.

It was thought when deep sea dredging was in its infancy that the unexplored depths, especially in tropical waters, might shelter lingering representatives of distant geological epochs, and that ammonites and trilobites might put in an appearance when search was made in proper quarters. Indeed, some naturalists went so far as to assert that the fauna of the deep sea was essentially that of the cretaceous period which had existed there uninterruptedly from past ages. These ideas have been swept away by actual research and while we cannot be said to know more than a small proportion of the abyssal fauna, we know enough of it to be sure that it is essentially of a recent character. The survival of some forms which once were supposed to exist only in a fossil state does not materially alter the modern character of the assemblage as a whole.

The knowledge of the conditions which exist over a great part of the sea-bed, and of the topographical features of the bottom, has however greatly modified the accepted views of geographical distribution. We now know that the conditions are such that there is no evident reason why a deep-sea species might not extend its range from the Antarctic Sea to the North Polar regions, and in fact very nearly such a range has been made out for a few forms. The free access of Antarctic cold waters to the northern ocean areas has even led to the suggestion that the Antarctic is the great centre of distribution from which species of all shores may have originated. However true this may be of some branches of the animal kingdom, our knowledge of the mollusca hardly warrants so general a deduction. A certain portion of our fauna, however, may be thus derived.

We know that at a relatively not very distant geological period the conditions of life on the globe were much more uniform than now. Both marine fossils and vegetable remains in the boreal and Arctic regions show that a much milder climate once prevailed there, while if we assume a relative disparity as great as now exists between arctic and tropical conditions at that time, we should have a heat in equatorial regions fatal to most life. Hence it is certain that a greater uniformity in conditions and in faunal characters once prevailed, and we cannot but believe that our present fauna is the descendant with modification of that ancient one. Certain

Digitized by Google

factors have so influenced the climate of the globe that that uniformity has been lost. Yet it would seem probable that the inhabitants of different coasts mainly originated not far from where we now find them, though important exceptions to this rule doubtless exist. The region which has in later times exhibited the most striking contrast of conditions of climate and sea level to the former general uniformity is the Arctic. It is geologically inferrible that this change has been, not slow and constant in one direction, but more or less fluctuating. The Arctic mollusks lend probability to this view for they are almost without exception characterized by wide specific variability; and the genera to which they belong are known as particularly variable even in those species which are not Arctic in their habitat. As the change in environment acted on the ancient fauna, one effect would be to exterminate such species as least readily accommodated themselves to changed conditions and to preserve a fauna of rapid and facile adaptability; perhaps mingled with a few forms particularly indifferent to influences of environment. These last must however in a large fauna always be exceptional.

This is the actual character of the Arctic mollusk-fauna and such features are only less remarkable in that of the Antarctic, because the latter region is almost destitute of coasts and in deep water such fluctuations of climate and sea level as have been referred to would be less readily transmitted and would lose most of their effect.

Other reasons why we may suppose that the present coast faunæ originated in the vicinity of their habitat are afforded by the results of a study I was enabled to make of the relations between the litoral and the immediately adjacent abyssal fauna in the West Indies from the collections of the Coast Survey steamer Blake, made under the direction of Prof. A. Agassiz.

These showed that more than ten per cent of the deep water species were also common to the litorale while a third of the genera were common to both shore and adjacent sea-bed. Only about one and a half per cent were distinctively arctic forms, such as we might expect to be in a large majority were the fauna derived from the North or South Polar Seas exclusively. In the same way we may explain the occurrence of *Voluta* and *Nacella* in the Aleutian Islands, rather as a survival from the Crag period when *Voluta Lamberti* flourished in Britain, than as offshoots from the Pat-

Digitized by Google

agonian fauna which have travelled northward and left no progeny by the way.

These somewhat crude and perhaps premature generalizations indicate the nature of some of the problems of which a study of abyssal life may afford a solution.

Studies of the embryological stages of a few of our American mollusks have been made in this country and creditable contributions to this branch of the subject have appeared almost every year for several years. Of the total number of American mollusks, those of which we have even an approximate embryological knowledge may be counted on the fingers, and the field therefore is vast. Special training and indefatigable patience, as well as facilities not at the command of all, are absolutely requisite for this most delicate form of investigation and we can hardly hope for rapid progress. Still the results of such enquiries, when properly authenticated and confirmed, are of such exceptional value as to be well worthy the devotion they require.

The anatomical features of the adult mollusks except in a few groups have been much neglected and are of the first importance. Binney and Leidy have done much among the land and fresh water species, and our Pacific Nudibranchs have been the subject of an important monograph by Bergh, while sundry species of marine mollusks have been more or less completely studied by various authors. It is nevertheless true that the soft parts of our commonest species are mostly entirely unknown or but superficially studied, so that even the characteristics of the adult anatomy of our common oyster are differently described by different naturalists and have been monographed by none. This is a reproach that it is in our power to remove, as the facilities required are comparatively limited and inexpensive and few students are so situated that mollusks of one kind or another are not within easy reach. It is true that Americans are not alone in remissness in this direction but that is no sufficient excuse.

The instinctive or mental phenomena which may be exhibited by living mollusks have not been subjected to investigation. It is true that a few observers have incidentally described actions which on mature consideration might be held to exhibit mental processes of a certain kind. The speaker has lately put on record certain observations which seem to indicate the possession, by some species of the genus *Helix*, of the power to recognize a call

Digitized by Google

or sound and to distinguish it from other calls or sounds of a similar character; and, since that publication appeared, he has received several less exact communications which would seem on the whole to confirm this conclusion.

We can hardly doubt, however (whether the particular instances referred to afford proof of it or not), that in a group containing so many animals of a high degree of organization, such as the cuttles and squids, for instance, mental processes of a tolerably complex nature must be carried on in many cases. That this subject has received no attention is a matter of regret and it would seem that a mere mention of it would be sufficient to set some observer at work. Given an aquarium or a snailery, both easily and cheaply constructed and stocked, and patience, time and a little ingenuity will supply all the needed conditions. It would not only seem to be a kind of research peculiarly adapted to attract and amuse an invalid, but one which, if properly conducted, would afford results of the highest scientific interest and value.

There is still another branch of the subject, of which the methods applied to other forms of animal life have occupied a very large portion of the thought and activity of the scientific world for more than twenty years. The results have revolutionized science and justly immortalized the remarkable naturalist who led the way. I refer to the modification of organic life by physical causes and the perpetuation of modifications by natural and sexual selection.

The fact does not seem to have been dwelt upon that the action of natural and especially of sexual selection is much more pronounced, and its effects necessarily must be far more important among organisms either in themselves of a high physical and mental rank reacting on each other (as birds and mammals), or with those upon which the actions of highly organized beings are effective in bringing about a selection of characters as in the case of plants visited by bees and wasps.

It must be granted that natural selection is universal in its action, and self-evident in its truth. It does not therefore follow, however, that it is equally efficacious in perpetuating peculiarities among all kinds of organisms. Indeed on consideration it will appear clearly that it cannot be, and that the more simple and plastic the organism, the less likely it is that natural selection will succeed in confining its variations within any given lines. Take, for instance, a pond full of *Amœba*, millions in number. The probability that

Digitized by Google

any given proliferation, or set of proliferations of the uniform protoplasm of any individual or number of individuals, can be so beneficial as to have any perceptible effect on subsequent generations, is mathematically infinitesimal. And this which is so evident in the case of structureless *Amœbæ* is more or less true throughout all the lower forms of life. It is only when advanced to a comparatively high stage of differentiation that organisms can offer, as it were, a handle for natural selection to take hold of.

There is probably no change or special characteristic in any organism of sufficiently high rank for which a plausible explanation cannot be assumed by the aid of natural selection. Herein lies the danger of this hypothesis. The offered explanation always *may* be true, but students have not always remembered that it also always *may* be false, and that therefore the hypothesis only becomes scientific when it is supported by proof. The *onus probandi* is not lessened by the production of a plausible hypothesis. The proof is often forthcoming in the case of higher organisms, and found with comparative ease. The difficulty increases with each step lower in the scale and practically, as I have shown, becomes insuperable among the lowest organisms. But it is among the lowest organisms that we must look for the first steps toward the grand divisions in which organic life is marshalled. It is here that the key to the great problem of systematic diversity in life is to be found, if at all, and it must be confessed, even at the cost of some disappointment, that natural selection alone does not meet the needs of the case.

American naturalists have from the first recognized more or less clearly the limitations of Natural Selection. By none has it been more clearly stated that natural selection originates nothing, and merely discriminates between already existing differences. By no other geographical group of students have such important expositions been made of the effect of physical forces on the organism and its parts, the relations of anatomical structure to strains and impacts, and of what may be termed the *rhythm* of development as shown by periodic acceleration and retardation in the life of the individual, of the group and of the race. The labors of Cope, Hyatt, Ryder, Morse and others among us, are no less fruitful than suggestive in these directions.

Some unnecessary anxiety seems to have been expressed by many in regard to the origin of variation. It is not doubtful that

Digitized by Google

variation is as much a necessity as natural selection. In all the unnumbered organisms which have existed since the appearance of life on the globe there can have been no two individuals whose circumstances, as regards their internal contents and qualities or their environment, have been absolutely identical. Many approached nearly to it, but absolute identity has not existed. It is therefore not a matter of surprise that variations exist, but rather that there is anything like uniformity among organic beings. The thing that is really extraordinary is that organic life should have so run in ruts, as one might say, that we can, in the majority of cases, refer without doubt a given organism to one of a few great fundamental groups which can be counted on the fingers.

I feel a reasonable confidence that the solution of the mystery lies in the direct physical action of the environment, by ways and methods few of which are yet understood, many of which may long remain mysterious but which in the course of time will undoubtedly be made clear by the research, the energy, the perseverance and the will of that most extraordinary of all organic mysteries, the human mind.

In this connection it seems a duty to refer to that remarkable work, the Principles of Biology, by Herbert Spencer, in which the actions and reactions of organism and environment are so clearly set forth, so many lines of investigation indicated and such pregnant suggestions offered to the philosophical inquirer, that we may fairly regard it as foreshadowing a major part, not only of conclusions definitely arrived at since its publication, but of those which are still hovering in the limbo of probability.

Since the mollusks occupy, in a certain sense, a middle ground between the higher groups, where natural selection has its freest play, and those lower categories, where its operations are veiled or inefficient, investigation of the laws of variation and of those influences which tend to stability of characters, is among them especially desirable.

We find, as by hypothesis we should find, that the influences of selection are most evident in those mollusks which by their terrestrial habitat are brought into the closest contact with enemies of relatively high intelligence such as birds and other vertebrates. In these the selected characteristics are chiefly those of color. The gray and dull appearance of species inhabiting arid regions is well known. It is not impossible that the primary cause of

Digitized by Google

this may be due to a less fluent secretion of the animal products which are the chief components of the pellucid substance and glistening epidermis of shells native to moister regions. It would naturally occur in the dry air of the desert that fluid products unprotected by an impervious epidermis would be less readily retained within the soft tissues of snails. In moister regions a tendency is especially noticeable among operculated Pulmonates, to striped markings of darker and lighter color, such as would tend to conceal them among the lights and shades of grass and herbage which they frequent; and one is tempted to refer the perpetuation and wide prevalence of this style of coloration to causes similar to those by which some have accounted for the vertical stripes of the tiger.

But to what is the origin of the microscopic sculpture of the same shells' most delicate and intricate tracery, constant in the species, to be attributed? It does not seem possible that it can be in any way useful.

Again, in tropical species the reflected lip of the aperture is often painted with exquisite rose, orange or yellow hues, entirely invisible under ordinary circumstances when the mollusks are alive. As they are reciprocally hermaphrodite, sexual selection can have no effect in fixing tints of beauty here. In fact, throughout the group, the most puzzling question, and one which presents itself continually, is that which demands the origin of complex combinations of color and form to which it is impossible to assign any utility. There is an Asiatic species of *Bulimus* of a lovely lemon color which, about the beginning of its last turn before forming the reflected lip which marks maturity, deposits a narrow black or bluish band across the whorl. There is no ridge, no interruption of the smoothness of the shell, no internal process corresponding to the band, nor any other touch of such color elsewhere.

An artist would say at once, the lemon color is heightened and the beauty of the shell greatly enhanced by its contrast with the dark band. But our mollusk is no æsthete and his poor eyes are believed to barely help him to distinguish light and shade, certainly not form or color. Yet we cannot doubt that there is a good and sufficient cause for this and numberless similar features among land shells.

Among marine forms the struggle for existence, after the embryonic stages are past, is much less violent. This arises partly from

Digitized by Google

the much more uniform conditions of life in the sea, partly from the general abundance of food contained in the sea water, and partly from the less intelligence of enemies, which are chiefly fishes and predaceous mollusks.

Since here development of superficial characters in any direction is hardly governed or limited by any sort of selection, we have most remarkable variety exhibited in externals with marked uniformity in structural features. Here, again, we are met with the question, What purpose is served by all this infinite variety of detail which is often, without a microscope, invisible to the observer, and how much more so to the creature itself and its companions of every kind? The exquisite painting of many species of *Conus* is visible only after death, being covered during life with a dense epidermis. The exceedingly delicate ramifications of many Murices, the shagreening of many Trochoids, the richly painted apertures of *Phyllonotus* and the lovely domes of the Cowries,—all these are beyond the perception of their owners or fellow creatures, are utterly useless to them as far as we know, and yet are stable characters within the species.

In certain features Hyatt has traced the influence of gravitation. Food has, without question, great importance especially in determining certain tints of color. I have shown how spirality might have developed from the effect of physical causes seconded by natural selection. In Alaska I noticed a species of *Litorina* which, when living on isolated rocks subjected to the full power of the surf, exhibited modification. The spire became shorter and nearly flat. The last whorl and aperture became enlarged and patulous; strong revolving ridges became rows of rounded nodules and the axis of the shell broad and thick. From this I concluded that those specimens which tended to vary in the directions mentioned possessed advantages over the ordinary form in resisting the action of the waves and therefore retaining their hold upon the rock and life. Once washed into the shifting sands between the rocks, they had small chance of survival. I have often thought of this as one of the most obvious instances I have observed of the action of selection among marine mollusca.

The Carrier-trochus family (*Phoridæ*) are remarkable examples at once of the unexplained acquisition of a valuable habit, its perpetuation by natural selection and in some cases its continued retention when no longer useful.

Digitized by Google

Certain of these shells pick up and attach to their upper surfaces bits of dead coral, stones and fragments of shell until they are entirely covered. Viewed from above as they must be for the most part by fishes and carnivorous mollusks nothing but dead and refuse matter is visible. It is evident that this must be a great protection both from enemies who would pass them by and from accidental concussions. It may be due to the latter incidental protection that the shells are or have become very thin and indeed barely more than a layer of cement sufficient to hold this extraneous matter in place. It is difficult to imagine how such a habit can have originated, for it is not the practice of gastropods in general and it must have been pretty generally adopted before it could have been of sufficient benefit to the genus at large to have been confirmed as a habit by selection. When this had once taken place its usefulness is obvious. However, it is still more strange that so valuable a habit should, as it has done in many species, fall partially into disuse, so that while the disadvantage of carrying round a burden of projecting and obstructive fragments is retained and indeed sometimes exaggerated by placing the fragments on the extreme periphery of the carrier's shell, the animal should fail to sufficiently cover itself so as to make its load a real protection. This is the case in several species which moreover exhibit a decided discrimination in the materials they collect, so that one species picks up only small dead bivalves, another fragments of coral, and, in one or two cases, only minute pebbles or grains of sand which are of no protection whatever and present the appearance of a mere attempt at decoration. The character and disposition of the load have become so uniform in many cases as almost to take rank as specific characters.

The few instances I have mentioned are merely typical of myriads. They sufficiently indicate the world of mystery which surrounds the life and progress of the members of an entire subkingdom of animals. General readers, perhaps some students, often gain an impression from the steady stream of scientific literature and the enthusiastic claims of some disciples of nature, that we are rapidly illuminating the inmost recesses of the world of knowledge, — that in fact there is little left to explore.

But those whose high privilege it has been to commune with Nature in her sacred haunts, to waste in studious mood the midnight oil and grasp by efforts slow, severe, prolonged, some new truth

Digitized by Google

from the mazy labyrinth,—these will feel with Newton that their labors in the past, and all that any single man may hope to add, are to the contents of great Nature's book but as the gleanings of some little child gathering shells along an ocean strand.

Yet, notwithstanding this, the student rightly feels that every new truth is gathered for all time and is its own reward; and that, in spite of human error, prejudice and weakness, imperfect comprehension of the glories of the harvest and faulty applications of experience, progress is constant. Before the strong breath of persevering and repeated investigation, flake by flake, the chaff is winnowed away. That which remains, fit for the granary of knowledge, is imperishable. Let us then accept the lesson, in graceful verse recorded by a poet naturalist, taught by the ever expanding camerated coil of pearly Nautilus, contemporary of the ages past as well as of the living present:—

"Year after year beheld the silent toil
That spread his lustrous coil;
Still as the spiral grew
He left his past year's dwelling for the new,
Stole with soft step its shining archway through,
Built up its idle door;
Stretched in his new found home and knew the old no more.

Thanks for the heavenly message brought by thee,
Child of the wandering sea,
Cast from her lap forlorn;
From thy dead lips a clearer note is borne
Than ever Triton blew from wreathèd horn;
While on mine ear it rings
Through the dark caves of thought, I hear a voice that sings:

Build thee more stately mansions, O my soul
As the swift seasons roll;
Leave thy low vaulted past!
Let each new temple, nobler than the last,
Shut thee from heaven with a dome more vast,
Till thou at length art free,
Leaving thine outgrown shell by Life's unresting sea."

Digitized by Google

VARIATIONS IN NATURE.

A Contribution to the Doctrine of Evolution, and the Theory of Natural Selection. By Thomas Meehan, of Germantown, Pa.

Members of the American Association for the Advancement of Science:—

You have honored me by a special invitation to address you on this occasion,[1] and you have suggested that I take for my theme some topic connected with plant life. I know that the papers I have given you during the past ten or fifteen years have led you to this kind consideration; and I therefore feel that I cannot do better than present to you now some of the impressions which my work has made on my own mind, in relation to some of the great questions of the day.

Perhaps the greatest of all questions is still the origin of species — the derivation of all the various forms we see — in brief, the doctrine of Evolution; and even where there is no doubt that one form has been evolved from some differing parent form, it has been by no means made so clear under what theory this growth of form is to be explained, that there can be no reasonable difference of opinion thereon. To my mind the doctrine of the origin of species as presented by Mr. Darwin cannot be controverted; and the theory of natural selection which he elaborated to sustain this doctrine requires only to be pruned of some abnormal growths to make it impregnable. This has been my task during the years referred to. Whenever I have seen weaknesses, I have adduced facts to oppose them. My task to-day is, as I hope, to show that the doctrine of evolution, and especially the theory of natural selection, is all the stronger for the work I have done.

[1] At the Cincinnati meeting the standing committee invited Mr. Meehan to occupy the chair of (the then) Section B, vacant through the inability of Dr. Geo. Engelmann, the elected Vice President, to be present. Mr. Meehan declined, fearing that his imperfect hearing would interfere with the proper performance of the duties of the chair. The Section then invited Mr. Meehan to deliver a special address at the next meeting of the Association.—Ed.

Digitized by Google

I am particularly glad that the opportunity has been afforded me to undertake this pleasant task at this time, when the whole world is in mourning for Charles Darwin, whose chief claim to our love lies in the earnestness with which he pursued this very theme. I shall have to point out now as heretofore what I regard as weak points in his arguments, not to refute his main propositions, but in the belief that they will be stronger without them. I think you will regard it as one of the most fitting tributes to his memory if I succeed in showing that his propositions are stronger than he himself knew.

Darwin has shown that under domestication and under cultivation variations have occurred among animals and plants which we should certainly regard as species if we found them in a wild condition and their derivation were unknown. He shows that there are variations in nature, and by the operation of a law of selection the intermediate die, leaving forms which seem distinct to us because the intermediate have been lost. These forms continue to vary, with selections as before, till in time we have the great diversity we see. To this there is added another principle which he terms inheritance, and which counteracts variation in some degree, holding and retaining a given form to some extent, but never totally overawing the tendency to vary.

I know of nothing in my own observations, or in the observations of others to contradict this view. Facts confirming them are now of almost every-day occurrence, and we find them in the commonest plants. Near my home in southeastern Pennsylvania, we find the common Virginia creeper, *Ampelopsis quinquefolia*, with five leaflets. In Texas, Mr. Buckley finds it with seven, in northern Pennsylvania it is found sometimes with three. Along the Canada line it is mostly with five, but sometimes with seven. In southeastern Pennsylvania the leaflets are usually broadly ovate, slightly serrate, dark green, and the flowers and fruit are borne on rather stout pedicels; in Colorado the leaflets are rather wedge shaped, deeply laciniate, of a somewhat glaucous green, and the pedicels slender. In southeastern Pennsylvania the secondary veins are delicate, curved, and diverging from each other as they extend towards the edge of the leaflet; along the shores of Lakes Erie and Ontario, especially on Goat Island, near Niagara, the veins are very prominent, straight, almost parallel, and give the appearance at first sight of horse-chestnut leaves. We do not

Digitized by Google

regard these outlying forms as species, we do not even consider them as varieties. But why? Merely because we find in what I will call the central form, a tendency to all the characters referred to. If this central one were to disappear, I think botanists would have no difficulty in regarding the outlying forms as well marked varieties, if not good species. It may be said that these are properly the results of conditions and not variations; that they are the results of accidental circumstances, and are not perpetuated under hereditary laws; but it is one of the discoveries of modern times that these local variations, as they would once have been styled, are just as capable of being perpetuated as the most undoubted species. There is no difference whatever in this respect. Given a fair chance in the struggle for life for the seed to grow and the plant to mature seed, and the race at once has all it requires to go on and perpetuate itself.

It is just here that the advocacy of the theory of natural selection often shows a weakness which I distinguish from the theory itself. Mr. Darwin himself seemed to believe that variation in nature was a slow process, and he continually refers to the gradual modifications going on through long ages.[2] He contends that "variability is not an inherent and necessary contingency" of existence[3], "but comes from the law of correlation of growth; to the direct action of the conditions of life; to use and disuse; to the intercrossing of species;"[4] and he is especially emphatic in stating his belief that variations are ever in the line of profit to the individual. His leading idea is that those individuals which receive the greater sum-totals of profitable variations are the best able to maintain themselves in the struggle for life; in other words every act of life, variation included, proceeds on the basis of individual good. We have been made familiar with this view in much that has been said on the cross-fertilization of flowers. It has been said that flowers have been made beautiful solely on the basis of utility to the plants which bore them. It led to the visits of insects, which then led to cross-fertilization; and cross-fertilization is believed to be a means whereby the progeny is better able to battle for existence. Utility is with him the basis of all individual action; the impelling force in all change.

[2] Darwin's Origin of Species, Chap. IV, paragraph 5, X, paragraph 4, V, summary.
[3] Darwin's Origin of Species, Chap. V.
[4] Darwin's Origin of Species, Chap. V.

Digitized by Google

I feel sure, however, that a careful view of variations in nature will show that there is not the slightest physiological advantage in many a form which has had a wide distribution, over other forms which have but a localized existence. In the forms of *Ampelopsis* I have referred to, and which would become species if the central form were lost, any one form is just as able to do battle as another. Whether it succeeds in establishing itself or not depends wholly on other circumstances than matters connected with the character of its leaves or inflorescence, so far as we have been able to observe them. Or, let us take a race of plants of simple structure and of great variety. The family of cacti will serve for illustration. Supposing all these to have sprung from one primordial form, and granting that its spines are for protection, what possible gain has any one species obtained among the vast variety of form of plant or spines which enables it on that account to get along better than its neighbor? Supposing one species had a fascicle of twenty spines, how would it be the gainer by developing a new species with but ten, or another one with forty? The only argument I ever heard in such cases is that they must be individually beneficial or they would not exist. This is not the kind of reasoning that will satisfy us to-day, especially as a different view of the objects of nature will furnish us with a better answer.

What are the objects of nature? What will this world and all its creatures be like a hundred centuries from now? We see by the past as compared with the present that the one great aim is development. Nothing now is as it was then; and yet how closely connected is the present with the past! Then, as now, there was a struggle for life; but the gain to the conquerors was far less to them than to us. In one word it is posterity at which nature aims. It is not only those who die in the struggle who abandon life that others may live. It is only a few more years, as seen in the light of ages, before those for whom the others seemed to die follow after. Self-sacrifice and not self-interest is nature's demand on us all. We are here as Nature's invited guests; to do her work; to assist in this work of developing the future. She makes our stay as pleasant to us as possible; we should not do her work willingly unless she did, but she ruthlessly removes us the moment we are no longer of use to her in her plans of development. All nature is at work; but all this work would be vanity if it were merely for

Digitized by Google

individual good, and utility ended with individual life. Look at some poor mother toiling for her children, perhaps in poverty, and with but the barest necessaries of life to eat,—without rest or sleep that they may be fed and clothed; watching over them day by day in sickness and suffering, till her own health gives away, and she becomes a human wreck. She takes pleasure of course in this sacrifice; her lot would be truly unbearable if she did not. But wherein is the individual benefit? No! her struggle is not for life. It is self-sacrifice. She is aiding Nature in her great law of development. Her work is for posterity.

Just as you see it among human beings, you find it among all other animals. The most selfish of all will lay down its life for its young; its work like ours is for the future of its race, rather than for any good which may accrue to its own existence.

We find precisely the same laws operating in the vegetable as in the animal world. We discover nothing in the behavior of plants to indicate that they are actuated by individual good, further than may be necessary to enable them to fall in with Nature's great aim of preparing for the future. Millions of seeds are produced for every one that grows; millions grow for every one that lives long enough to flower; millions of flowers open for every one that yields seeds, and millions on millions of grains of pollen are produced for every one grain that is of service in fertilization. Under the individual utility theory all this is utter waste, and that plant life should be employed for, say, almost the whole of its existence, in sheer waste of effort solely that one moment might be possibly useful, is beyond all comprehension. It is customary to explain this by the guess that nature indulges in all this waste in order that there shall be no chance of failure. But even the thousandth part of all this waste would be sufficient for this permanent policy of insurance. Take for instance the sweet chestnut, *Castanea vesca*, count the number of stamens in a single flower of a male catkin, and multiply by the number of flowers the catkin bears; then get an idea of the number of male catkins on a single tree. Remember that each of the anthers contains hundreds of pollen grains, and conceive if you can the myriad millions of pollen grains on a single tree. Now look at your few bushels of chestnuts, and remember that a single pollen grain served for the production of each nut, and believe if you can that nature induced that tree to produce a million pollen grains in order that one

Digitized by Google

should surely do its work! Independently of this consideration we now know that these showy male flowers fall early, and, there is reason to believe, before the female flowers open, and that pollinization is effected by a second crop of male flowers which appear simultaneously and on the same spike with the female. Moreover, we find, by what are known as cleistogene flowers, that nature can effect fertilization without any waste of pollen were she so minded. In *Viola* there is about a grain of pollen to each ovary in the cleistogamous flower. Another point has been suggested,— that this wonderful amount of vegetable exertion is to secure cross-fertilization, and this seems to be sustained by the small amount produced by cleistogene flowers; but allowing for all this it still does not account for the enormous waste. But we find these surplus seeds, surplus plants, surplus pollen, are useful, not to the parents which bore them, not in any way to themselves, but as sacrifices to posterity. They serve as food. They die that something else may live. They all work in with Nature's grand aim of developing something for the future. At the present time the eyes of science are turned to the past. We compare the dim view with that which is about us, and we perceive that all things have worked together for the good of the whole. We see that nothing has lived in vain. We know that in the general economy of nature there is no waste anywhere. Had the past turned to where we stand it would have seen nothing. People then would have had a better right to believe than we, that individual utility is at the bottom of all life; that "No. 1 is the first law of nature." It is for us to see that self-sacrifice was really their lot, and what was the future for them will still be the law of the future as the world rolls on.

To my mind, then, no doctrine of evolution, no theory of natural selection, will be perfect that looks to individual or immediate utility alone as its foundation-stone. Self-sacrifice, the good of the future at the expense of the individual or of the race, if need be, must hold the primal rank.

Let us now turn to look at nature. I am satisfied that not even the wonderfully acute powers of observation of the great Darwin led him to perceive the wonderful variations there are in vegetation everywhere. It is a common saying that things are "as much alike as two peas;" but if you look with a microscope you will not find two peas alike. No two leaves on a tree can be

Digitized by Google

found exactly alike. In outline, serration, pubescence, venation, some one thing or another you will find unlike the one you compare with.

Individual plants are not like other plants. You will be surprised if you compare closely to find how much they differ. It is best to take for examination those genera which have but a single species, so that no objections from cross-fertilization may arise. Take the ox-eye daisy, *Chrysanthemum Leucanthemum*, *Linaria vulgaris*, or *Epigæa repens*.[5] I name these because they are common, and because I have carefully examined them, and I have never found two plants from different seeds, but differed in some respect, either in foliage or inflorescence. You will find differences in cotyledons as well as in the primary leaves which succeed them. Examine a series of first leaves of *Robinia pseud-acacia* the common locust; some are elongated, some orbicular, some panduriform, some oblate, and these varying again in other characters. I have examined, for these facts, plants obtained from seed of the same tree. I also exhibit a series of *Pyrus*, or *Cydonia Japonica*, which I do know were raised from seed produced on one bush. There are some two hundred seedlings, and not only are no two alike, but there are amazing differences of form in the foliage, from narrow saliciform to almost round. Our esteemed fellow member and secretary of this meeting, Mr. William Saunders, showed me some seedling gooseberries of remarkable character. The seed was all from one berry, but the plants varied; some with very bristly fruit, some with smooth fruit, and I have myself seen ovate and globular fruited plants also raised from seed of one berry. I also exhibit two branches from two plants of *Rosa cinnamomea*, both plants raised from seed from one seed vessel, in which you see one branch almost wholly free of thorns and bristles; the other densely, nay ferociously, armed with long bristles and thorns. I could indefinitely continue these illustrations; you may at any time find numbers for yourselves. You will have no difficulty in believing that perpetual variation is a condition of existence. These variations have no special physiological value; no one will say that the possessor of one form has any special advantage over another in the struggle for life. Unless they are the incipient stages of that development which is to

[5] Proceedings Academy of Natural Sciences of Philadelphia, pp. 155-6.

Digitized by Google

result in species and genera in the future, they have absolutely no meaning at all.

Some who have noticed this fact of universal variation attach little importance to it. They believe it is but what they term a limited variation, extending only to a certain contracted line, and then returning; that such variations are at best but temporary and have no place under hereditary law. I confess that I once held this opinion. In a certain sense it is correct. If a leaf, oval, normally as we would say, changes until it becomes round, it cannot afterwards become rounder. A plant with a small flower develops one with a large flower. As flowers are morphologically changed leaves, a flower cannot become larger than the original leaf-type will permit. In this sense there must be a limit to variation, but in no other sense that I can find.

In the many combinations which can be made with a few elements, there is continuous change.

In regard to heredity I know from many years' experience, and contrary to generally received opinion, that any variation that appears in nature is capable of being perpetuated under the laws of heredity in just the same degree as those plants which we commonly regard as species. Let a white variety of a colored flower appear, and its progeny will continue white-flowered. I have had several generations of purple-leaved berberries and weeping peaches, and weeping ashes produce weeping seedlings. Purple peaches, golden spiræas, variegated plants of all kinds reproduce their kind with only just so much variation as we find in connection with all things.

I may remark further that sex, while to some extent an agent under the laws of variation, acts with greater force as an agent under heredity. Under the laws of variation A may depart somewhat from B on one side; and on the other side C departs from B; but an insect cross-fertilizing A with the pollen of C brings the progeny again towards B, and thus cross-fertilization acts as a check on rapid divergence. I have noticed this action of bees in the case of variations in *Linaria vulgaris*.[6] On the other hand there may be three variations, A, B, C; B being an advance on A, but B is fertilized by C; C having no opportunity to perpetate itself dies out; but B succeeding in this has gained a step

[6] Proceedings of Academy of Natural Sciences of Philadelphia, 1872, p. 235.

Digitized by Google

through the sexual agency of C. To my mind the operation of the law of sex in connection with heredity, checking too great a tendency to wander off and mix with the world, producing as it were a sort of family relationship which it takes several generations under the law of variation to break up, is a far more legitimate theory of the use of cross-fertilization than anything which has been brought out under the more selfish hypothesis of utility to the individual or to its immediate descendants.

Now let us formulate our own theory of evolution and the origin of species by natural selection.

Nature primarily knows only the individual. This individual is made to reproduce itself after a short term of life, but with some general resemblance; yet every individual varies from its parent, some in one direction, some in another, the object of this variation being to reach some harmonious result far away in the future — a future which seems to us almost an eternity of years. The march of this variation is held in temporary check by heredity, aided especially by the influence of sex. Individuals become a large community. The wide world is around them. Those on the outside of the circle battle with the rest of the world; those in the interior battle also with themselves. For illustration we will call the community a pine forest. Millions of seeds are produced on the trees of those of the interior, not a hundred in a million will grow; of these hundred not ten may come to be young trees; and of these ten not more than one may get the chance to reproduce itself. Suppose that one happens to be what the human mind should regard as a striking variation; cross-fertilization steps in and draws it back to the original. No matter how great might be the physiological value of the variation to that tree in any ordinary struggle for life, antagonizing circumstances render the point gained of no possible use to it. But if the variation find itself on the outside of this circle, with no struggle with its own kind, with plenty of chance to mature its seed, an abundance of room for the young plants to develop, little opportunity for cross-fertilization to mar the distinctive variation it has gained, and still gain a chance for the progeny to reproduce in the same way, heredity will give you a distinct series, which will lead to arguments whether they are hybrids, varieties or species. If, however, acres of the interior of the forest get destroyed, and nothing but the outline of the circle is left, if there should arise a sort of Pacific Ocean over what was

Digitized by Google

once the land, and only, say Japan, remain on the west, and the Atlantic United States on the east, you would have only the modern variations left to tell the ancient story. It may not be the centre which meets this destructive fate. Some forms, as for instance *Onoclea sensibilis*, the well known fern, may avoid destruction, and get enwrapped in the laws of heredity for a hundred thousand years, while some or all of its progeny may have been swept away. There is no reason why grandparents among species may not survive long after every child or grandchild has ceased to be. The advance, the resting spot for the family, the further advance and the changes, the weeding out, and the survival of the fittest to carry on the great work of destiny,— how simple thus becomes the doctrine of evolution and the theory of natural selection!

We have taken the facts for our own conclusions as we have gone along; let us finally examine one more illustration. Here we have a series of cones made up from trees growing within a circuit of, say, a day's ride around Hammonton, N. J. They are all from trees of *Pinus rigida*. From one tree we have cones four inches long and almost round; others four inches long and not two inches wide; the one would be called almost linear, the other almost globose. Others are flat at the base and will stand upright; the others are rounded and roll over like marbles. One is so small as to be not more than an inch in length, and yet with perfect seeds. Some have very narrow scales, others have very wide ones. Some open slightly, but never much, others open so much that they reflex. Then there are some which to the best of my belief never open. Then we find several characters going along together. For instance, it is the narrow scaled forms which recurve; while the broader the scale the less tendency there is in the cone to open and scatter the seed. We see that all these cones belong to *Pinus rigida*, because between each cone there is but a shade of difference. Now I have already shown you that seeds of any one of these cones would produce trees bearing cones with a general resemblance to the parent cone. Supposing all these intermediates were to be crowded out, and only the two extremes left, there is not a botanist but would regard them as two distinct species. Now what I have given you as a suppositious case is an actual truth. We have at one end *Pinus rigida*, at the other *Pinus serotina* of the older botanists. *Pinus serotina* is no longer considered a good species. Why? Not because there was any error in the

Digitized by Google

original description, but simply because we have found the missing links. You cannot conceive of any physiological value to the individual or to the race to spring from any of these changes from the original form; you will not for one moment believe that in any one of these forms there is the slightest advantage to be gained over the other in what would be generally understood as the struggle for life. On the contrary, you will find one which has the cone closed, and in this particular lost the power to readily distribute the seeds; lost the great advantage of numbers in the tremendous battle; is the one form which has so well succeeded in establishing itself as to be the only one which has gained a distinctively botanical name.

I think you will come to agree with me that "the race is not always to the swift, nor the battle to the strong" is just as true in the development of species as in morals; that the whole round of organic existence is not one of self-seeking advantage over one's neighbor, but one of intrepid self-sacrifice; and that the doctrine of evolution and the theory of natural selection are rendered clearer and stronger by the perception of these facts.

I might rest here, but science cannot afford to ignore the objections sometimes made that evolution and especially the theory of natural selection is opposed to doctrines which are held sacred by so large a portion of the human race. I would rather that we could ignore them. Science should be allowed to work out its own salvation, if there be aught in it worth saving. It would die of itself when it had nothing to live on; but objections being made it is a gain to science to show that they have no force.

The essential doctrine of Christianity is self-sacrifice. It was the great burden of its founder's teaching, and was illustrated by the sacrifice of his own life. True happiness to him was to do the will of Him who sent him.

How exactly does this not accord with the laws of nature as I have unfolded them? Variation, as we have seen, is established, not that things which vary derive any special advantage by the variation, but that all varied things may work the better together for the good of some future object, to them unknown. Their work is of no advantage to them, but the task is made pleasant, so that the work may still go on.

And the reaper, death, gathers in his harvest of species, just as he gathers in his harvest of individuals, without regard to youth or

Digitized by Google

old age, to the strong or to the weak, oftentimes confounding our reason by the mere assertion of his will, and leaving us no alternative but to believe that natural selection, true as it is and must be, is still in the hands of some directing power which we have not yet fathomed, but which is making all things work together for some great future object, of which, as yet, not the faintest glimmer has been perceived by the wisest man.

There is no conflict between the doctrine of evolution with its theory of natural selection and the essential doctrines of Christianity. Rather, as I believe, will the day arrive when those who advocate these views will be regarded as Christianity's best friends.

Digitized by Google

PAPERS READ.

REMARKS CONCERNING THE FLORA OF NORTH AMERICA. By ASA GRAY, of Cambridge, Mass.

IN the remarks which I have to offer to this Section, you will understand the word *Flora* to be written with a capital initial. I am to speak of the attempts made in my own day, and still making, to provide our botanists with a compendious systematic account of the phænogamous vegetation of the whole country which the American Association calls its own.

I shall make no effort to avoid the personal turn which my narrative is likely to take. In fact, it will be seen that I have partly a personal object in drawing up this statement.

Only two Floras of North America have ever been published as completed works, that of Michaux and that of Pursh. A third was begun (by Dr. Torrey, assisted by a young man who is no longer young), by the publication in the summer of 1838 of a first fasciculus; the first volume of 700 pages was issued two years afterward; and 500 pages of the second volume appeared in 1841 and in the early part of 1843. The time for continuing it in the original form has long ago passed by. Its completion in the form in which I have undertaken it anew, is precarious. *Precarious* in the original sense of the word, for it is certainly to be prayed for: precarious, too, in the current sense of the word as being uncertain; yet not so, according to an accepted definition, viz.: "uncertain, because depending upon the will of another;" for it is not our will but our power that is in question; and it is only by the combined powers and efforts of all of us interested in Botany that the desired end can possibly be attained.

It were well to consider for a moment how and why it is that a task which has twice been — it would seem — easily accomplished has now become so difficult.

The earliest North American Flora, that of the elder Michaux, appeared in the year 1803. It was based entirely upon Michaux's own collections and observations, does not contain any plants which he had not himself gathered or seen, is not, therefore, an

Digitized by Google

exhaustive summary of the botany of the country as then known, and so was the more readily prepared. Michaux came to this country in 1785, returned to France in 1796, left it again in Baudin's expedition to Australia in 1800, and died of fever in Madagascar in 1802. The Flora purports to be edited by his son, F. A. Michaux, who signed the classical Latin preface. The finish of the specific characters, and especially the excellent detailed characters of the new genera, reveal the hand of a master; and tradition has it that these were drawn up by Louis Claude Richard, who was probably the ablest botanist of his time. This tradition is confirmed by the fact that Richard's herbarium (bequeathed to his son, and now belonging to Count Franqueville), contains an almost complete set of the plants described, and I found that the specimens of Michaux supplied to Willdenow's herbarium at Berlin were ticketed and sent by Richard. Not only the younger Richard but Kunth also habitually cited the new genera of the work as of Richard, and some others have followed this example. Singularly enough, however, there is no reference whatever to Richard in any part of the Flora, nor in the elaborate preface. The most venerable botanist now living told me that there was a tradition at Paris that Richard performed a similar work for Persoon's *Synopsis Plantarum*, and that he declined all mention of his name in the synopsis and in the Flora, because the two works — contrary to the French school — were arranged upon the Linnæan Artificial System. He had his way, and the tradition may be preserved in history; but his name cannot be cited for the genera *Elytraria*, *Micranthemum*, *Elodea*, *Stipulicida*, *Dichromena*, *Oryzopsis*, *Erianthus*, and the like. For, by the record these are of *Michaux*, *Flora Boreali-Americana*, and not of Richard.

Michaux's explorations extended from Hudson's Bay, which he reached by way of the Saguenay, to Florida, as far, at least, as St. Augustine and Pensacola; he was the first botanical explorer of the higher Alleghany Mountains, and, crossing these mountains in Tennessee, he reached the Mississippi in Illinois, and was as far south as Natchez. His original itinerary, which I once consulted, is preserved by the American Philosophical Society, at Philadelphia, to which it was presented by his son. It ought to be printed. That little journal shows that it was not Michaux's fault that the first Flora of North America was restricted to the district east of the Mississippi River. He had a scheme for

Digitized by Google

crossing the continent to the Pacific. He warmly solicited the government at Washington to undertake such an exploration, and offered to accompany it as naturalist. This may have been the germ or the fertilizing idea of the expedition of Lewis and Clark, which was sent out a few years afterward by Jefferson, to whom, if I rightly remember, Michaux addressed his enterprising proposal.

Leaving out the Cryptogams of lower rank than the Ferns, we find that the Flora of Michaux, published at the beginning of this century, say eighty years ago, contains 1530 species, in 528 genera. No very formidable number; as to species (speaking without a count) little over half as many as are described in my Manual of the Botany of the Northern States, which covers less than half of Michaux's area.

Eleven years afterward, namely, in the year 1814 (the preface is dated December, 1813), appeared the second Flora of North America, namely the *Flora Americæ Septentrionalis* by Frederick Pursh. This was not confined to the author's own collections, but aimed at completeness, or to give "a systematic arrangement and description of the plants of North America, containing, besides what have been described by preceding authors, many new and rare species, collected during twelve years' travels and residence in that country."

It appears that Pursh was born at Tobolsk, in Siberia, of what parentage we do not know. He himself tells us, in his preface, that he was educated in Dresden, and he came to this country — to Baltimore and Philadelphia—at the close of the last century, when he must have been only twenty-five years old. He was able to make the acquaintance not only of Muhlenberg, who survived until 1815, and of Wm. Bartram, who died in 1823, but also of the veteran Humphrey Marshall, who died in 1805. His early and principal patron was Dr. Benjamin Smith Barton, who supplied the means for most of the travels which he was able to undertake, and who, as Pursh states, "for some time previous had been collecting materials for an American Flora." Pursh's personal explorations were not extensive. From 1802 till 1805 he was in charge of the gardens of Wm. Hamilton, near Philadelphia. In the spring of the latter year, as he says, he "set out for the mountains and western territories of the Southern States, beginning at Maryland and extending to the Carolinas (in which tract the

Digitized by Google

interesting high mountains of Virginia and Carolina took my particular attention), returning late in the autumn through the lower countries along the sea-coast to Philadelphia." But, in tracing his steps by his collections[1] and by other indications, it appears that he did not reach the western borders of Virginia nor cross its southern boundary into the mountains of North Carolina. The Peaks of Otter and Salt-pond Mountain (now Mountain Lake) were the highest elevations which he attained. Pursh's preface continues: "The following season, 1806, I went in like manner over the Northern States, beginning with the mountains of Pennsylvania and extending to those of New Hampshire (in which tract I traversed the extensive and highly interesting country of the Lesser and Great Lakes), and returning as before by the sea-coast." The diary of this expedition, found among Dr. Barton's papers and collections in possession of the American Philosophical Society, has recently been printed by the late Mr. Thomas Potts James. It shows that the journey was not as extended or as thorough as would be supposed; that it was from Philadelphia directly north to the Pokono Mountains, thence to Onandaga, and to Oswego,—the only point on the Great Lakes reached,—thence back to Utica, down the Mohawk Valley to Saratoga, and north to the upper part of Lake Champlain and to the lesser Green Mountains in the vicinity of Rutland, but not beyond. Discouraged by the lateness of the season, and disheartened—as he had all along been — by the failure and insufficiency of remittances from his patron, Prush turned back from Rutland on the 22d of September, reached New York on the 1st of October, and Philadelphia on the 5th. The next year (1807) Pursh took charge of the Botanic Garden which Dr. Hosack had formed at New York and afterward sold to the State, which soon made it over to Columbia College.[2] In 1810, he made a voyage to the West Indies for the recovery of his health. Returning in the autumn of 1811, he landed at Wiscasset, in Maine, "had an opportunity of visiting Professor Peck of Cambridge College, near Boston," and of seeing the alpine

[1] In herb. Barton and herb. Lambert.

[2] Expecting, no doubt, that it would be kept up. But "the Elgin Botanic Garden" was soon discontinued. It occupied the block of ground now covered by the buildings of the College, and the surrounding tract—now so valuable—from which the College derives an ample revenue. *Noblesse oblige*, and it may be expected that the College—so enriched — will, before long, provide itself with a botanical professorship, and see to the careful preservation and maintenance of the precious Torrey Herbarium, which it possesses along with other subsidiary herbaria.

Digitized by Google

plants which Peck had collected on the White Mountains.[3] At the end of the latter year or early in 1812 he went to England with his collections and notes; and at the close of 1813, under the auspices of Lambert, he produced his Flora, consulting, the while, the herbaria of Clayton, Pallas, Plukenet, Catesby, Morison, Sherard, Walter, and that of Banks. Evidently such consultations and the whole study must have been rapid. The despatch is wonderful. One can hardly understand the ground of the statement made by Lambert to my former colleague, Dr. Torrey, that he was obliged to shut Pursh up in his house in order to keep him at his work.

I know not how Pursh was occupied for the next four years, nor when he came to Canada. But he died here at Montreal, in 1820, at the early age of forty-six. More is probably known of him here. If I rightly remember, his grave has been identified, and a stone placed upon it inscribed to his memory.[4] A tradition has come down to us — and it is partly confirmed by a statement which Lambert used to make, in reference to the vast quantity of beer he had to furnish during the preparation of the Flora—that, in his latter days, our predecessor was given to drink, and that his days were thereby shortened.

In Pursh's Flora we begin to have plants from the Great Plains, the Rocky Mountains, and the Pacific Coast, although the collections were very scanty. The most important one which fell into Pursh's hands was that of about 150 specimens, gathered by Lewis and Clark on their homeward journey from the mouth of Columbia River. A larger collection, more leisurely made on the outward

[3] It is at Wiscasset, therefore, that Pursh's "*Plantago cucullata* Lam. . . . . in wet rocky situations, Canada and Province of Maine," is to be sought. Mr. Pringle has recently found the related *P. Cornuti* (which may be the plant meant), in Lower Canada, not far from the other side of Maine.

It must have been in Professor Peck's herbarium (no longer extant), that Pursh saw what he took to be *Alchemilla alpina*, which he remarks "*v. s.*" and refers to from memory only, probably mistakenly. For it has not since been detected either in Vermont or New Hampshire, or anywhere in North America; and Pursh's Journal makes it certain that he did not reach any alpine region in the Green Mountains.

[4] In the Canadian Naturalist, Principal Dawson gives a brief account of the transference of the remains of Pursh from a grave-yard below Montreal, in which they were interred, to the beautiful Mount Royal Cemetery, where they rest in a lot purchased for the purpose and under a neat and durable granite monument, provided by the naturalists of Montreal and their friends. A small company of botanists, led by Dr. Dawson, visited the spot shortly after the reading of this paper. We learned that Pursh had botanized largely in Canada, in view of a Canadian Flora, and that his collections were consumed by a fire at Quebec shortly before his death, to his extreme discouragement.

Digitized by Google

journey, was lost. Menzies in Vancouver's voyage had botanized on the Pacific coast, both in California and much farther north. Some of his plants were seen by Pursh in the Banksian Herbarium, and taken up. I may here say that in the winter of 1838–39 I had the pleasure of making the acquaintance of the venerable Menzies, then about ninety-five years old.

In the Supplement, Pursh was able to include a considerable number of species, collected by Bradbury on the Upper Missouri, in what was then called Upper Louisiana,—much to the discontent of Nuttall, who was in that region at the same time, and who, indeed, partly and imperfectly anticipated Pursh in certain cases, through the publication by the Frasers of a catalogue of some of the plants collected by Nuttall.

To come now to the extent of Pursh's Flora, published nearly sixty-nine years ago. It contains 740 genera of Phænogamous and Filicoid plants, and 3076 species,—just about double the number of species contained in Michaux's Flora of eleven years before.

I must omit all mention of more restricted works, even such as Nuttall's Genera of North American Plants, which came only four years after Pursh's Flora; also the Flora Boreali-Americana of Sir Wm. Hooker, which began in 1829, but was restricted to British America. I cannot say how early it was that my revered master, Dr. Torrey, conceived the idea of the Flora which he at length undertook. But he once told me that he had invited Nuttall to join him in the production of such a work, and that Nuttall declined. This must have been as early as the year 1832, that is, half a century ago. My correspondence with Dr. Torrey began in the summer of 1830, when I was a young medical student, and three or four years afterward I joined him at New York and became, for a short time, his assistant, for all the rest of his life his botanical colleague. He was very much occupied with his duties as professor, chiefly of chemistry; he had not yet abandoned the idea of completing his Flora of the Northern and Middle States, the first volume of which was finished in 1824, while yet free from all professional cares. Although working in the direction of the larger undertaking, the *Flora of North America* did not assume definite shape before the year 1835. I believe that some of the first actually-prepared manuscript for it was written by myself in that or the following year. I was then and

Digitized by Google

for a long time expecting to accompany the South Pacific Exploring Expedition, as originally organized under the command of Commodore Ap. Catesby Jones, but which was subject to long delay and many vicissitudes; during which, having plentiful leisure, I tried my 'prentice hand upon some of the earlier natural orders. Before the expedition, as modified, was ready to sail, under the command of Capt. Wilkes, I had accepted Dr. Torrey's proposal that I should be his associate in the work upon which I had made a small beginning as a volunteer. Two parts, or half of the first volume (360 pages), of this Flora, were printed and issued in July and October, 1838.

It was thought at first, in all simplicity, that the whole task could be done at something like this rate. But, apart from other considerations, it soon became clear that there had been no proper identification of the foundation-species of the earlier botanists, from Linnæus downward; and that our Flora could not go on satisfactorily without this. Dr. Torrey had, indeed, some years before, made a hasty visit to Hooker at Glasgow, to London, and to Paris; but the taking of a few notes upon some particular plants in the herbaria of Hooker, Lambert, and Michaux, and the acquisition, from Hooker, of a good set of the Arctic plants of the British explorers, was about all that had been done. I proposed to attempt something more; so, taking advantage of a favorable opportunity, I sailed for Liverpool in November, 1838, and devoted a good part of the ensuing year to the examination of the principal herbaria, which I need not here specify, in Scotland (where the important one of Sir Wm. Hooker still remained), England, France, Switzerland and Germany, namely, those which contained the specimens upon which most of the then-published North American species had been directly or indirectly founded, especially those of Linnæus and Gronovius, of Walter, of Aiton's Hortus Kewensis, Michaux, Willdenow, Pursh, and the later ones of DeCandolle and Hooker.[5]

After my return the work made good progress; the remaining half of the first volume was brought out in the spring of the year 1840, and by the spring of 1843 the 500 pages of the second volume, mostly occupied by the vast order Compositæ, had been issued. But meanwhile I had in my turn to assume professorial

[5] See, in this connection, "Notices of European Herbaria particularly those most interesting to the North American Botanist," in this Journal, vol. xl, January, 1840.

Digitized by Google

duties and incident engagements,—with the result that, although the study of North American plants was at no time pretermitted, either by Dr. Torrey while he lived, or by myself, we were unable to continue the publication during my associate's lifetime; and it was only recently, in the spring of 1878, that I succeeded in bringing out, in a changed form, another instalment of the work, completing the *Gamopetalæ*.

In the interval I had made two year-long visits to Europe for botanical investigation, the first partly relating to the botany of the South Pacific, the second wholly in view of the North American flora. And since this last publication still another visit—the fourth and we may suppose the last—of the same character and the same duration, has been successfully accomplished.

The serious question, in which we are all concerned, arises, whether this work can be carried through to a completion, and the older parts (wholly out of print and out of date), reëlaborated —I will not say by my hands—but in my time, or soon enough to render the whole a reasonably full and homogeneous representation of the North American flora, as known in this latter part of the nineteenth century. And it brings us to consider why the undertaking, to which so much time has been devoted, should be so slow of accomplishment.

If this slowness is a constant wonder and disappointment to most people interested in the matter, I can only add that it is hardly less so to myself. It is a constant surprise—if one may so say—that the work does not get on faster.

Of course the undertaking has become more and more formidable with the enlargement of geographical boundaries and of the number of species discovered. As to the increase in the number of species to be treated, we have by no means yet reached the end. The area, that of our continent down to the Mexican line, we trust is definitely fixed, at least for our day. And, since we cannot be rid of the peninsula and keys of Florida, which entail upon us a considerable number of tropical species, mostly belonging to the West Indies—the southern boundary is now as natural a one as we can have.

The area which Pursh's Flora covered was, we may say, the United States east of the Mississippi, with Canada to Labrador, to which was added a couple of hundred of species known to him outside these limits northwestward.

Digitized by Google

Torrey and Gray's Flora took the initiative in annexing Texas, ten years before its political incorporation into the Union; although the only plants we then possessed from it were certain portions of Drummond's collections. California was also annexed at the same time, on account of Douglas's collections, and those of Nuttall, who had just returned from his visit to the western coast, which he reached by a tedious journey across the continent over ground in good part new to the botanist. Douglas had already made remarkably full collections along a more northern line. The British arctic explorers, both by sea and land, had well developed the botany of the boreal regions, and Sir Wm. Hooker was bringing out the result in his Flora of British America. Of course our knowledge of the whole interior and western region was small indeed, compared with the present; and the botany of a vast region from the western part of Texas to the Californian coast was absolutely unknown, and so remained until after the publication of the Flora was suspended.

As to the number of species which Torrey and Gray had to deal with, I can only say that a rapid count gives us for the first volume about 2200 Polypetalæ; that there are 109 species in the small orders which in the second volume precede the *Compositæ;* and that there are of the *Compositæ* 1054. So one may fairly conclude that if the work had been pushed on to completion, say in the year 1850, the 3076 species of Pursh's Flora in the year 1814 might have been just about doubled. Probably more rather than less; for if we reckon from the number of the *Compositæ*, and on the estimate that they constitute one-eighth of the phænogamous plants of North America, instead of 6150, there would have been 8430 species known in the year specified.

It most concerns us to know the number of species which, after the lapse of thirty years more—years in which exploration has been active, and has left no considerable part of our great area wholly unvisited—the now revived Flora has to deal with. We can make an estimate which cannot be far wrong. In the year 1878, my colleague, Mr. Watson, finished and published his Bibliographical Index to the Polypetalæ of North America, covering, that is, the same ground as the first volume of Torrey and Gray's Flora, completed in 1840. In it the 2200 species of the latter date are increased to 3038. The "*Gamopetalæ* after *Compositæ*" in the Synoptical Flora, brought out in the same year,

Digitized by Google

contains 1656 species. The two together must make up half of our phænogamous botany, that is, adding the increase of the last four years, about 5000 species. And so Mr. Watson adopts the estimate of 10,000 species for our known Phænogams and Ferns. My expression is that the species of *Compositæ* have increased at a rate which, unless they exceed the eighth part of our Phænogams, will warrant a still higher estimate. The number of introduced species of various orders, which will have to be enumerated and most of them described, is, unhappily, fast increasing,[6] and new indigenous species are almost daily coming to us from some part or other of our wide territory; so that the 10,000 species of this estimate may before long rise to eleven or twelve thousand. Only the experienced botanist can form a just idea of what is involved in the accurate discrimination and proper coördination of 10–12000 species, and in the putting of the results into the language and form which may make our knowledge available to learners or to succeeding botanists.

Moreover, there is of late an *embarras des richesses* which is becoming serious as respects labor and time. The continued and ever increasing influx of materials to Cambridge, beneficial as it ever is, is accountable for this retardation of progress in a greater degree than almost any one would suppose. The herbarium, upon whose materials this work is mainly done, and which has been, like the Temple, full forty and six years in building, has received the contributions of two generations of botanists, and the Torrey herbarium goes back one generation further. Still the number of American specimens annually coming to it is greater than in most former years. Apart from the mere selection and care of these, consider how in other ways it affects the rate of progress of the Flora. The incoming of additional specimens may at a glance settle doubts as to the validity of a species; but new specimens are as apt to raise questions as to settle them; more commonly they raise the question as to the limitation and right definition of the species concerned, not rarely, also, that of their validity. When one has only single specimens of related species, the case may seem clear and the definition easy. The acquisition of a few more, from a different region or other conditions, almost always

[6] I say "unhappily," for they adulterate the natural character of our flora, and raise difficult questions as to how much of introduction and settlement should give to these denizens the rights of adopted citizens.

Digitized by Google

calls for some re-consideration, not rare for re-construction. People generally suppose that species, and even genera, are like coin from the mint, or bank notes from the printing press, each with its fixed marks and signature, which he that runs may read, or the practised eye infallibly determine. But in fact species are judgments—judgments of variable value, and often very fallible judgments, as we botanists well know. And genera are more obvious judgments, and more and more liable to be affected by new discoveries. Judgments formed to-day—perhaps with full confidence, perhaps with misgiving—may to-morrow, with the discovery of new materials or the detection of some before unobserved point of structure, have to be weighed and decided anew. You see how all this bears upon the question of time and labor in the preparation of the Flora of a great country. If even in old Europe the work has to be done over and over, how much more so in America, where new plants are almost daily coming to hand. It is true that these fall into their ranks, or are adjustable into their proper or probable places, but not without pains-taking and tedious examination.

Of our Flora, it may indeed be said, that "if 'twere done when 'twere done, then 'twere well it were done quickly." But I may have made it clear that, in the actual state of the case, it is likely to be done slowly. At least you will understand why thus far it has been done slowly. As to the future, if it depended wholly upon me, the completion would obviously be hopeless. I need not say that our dependence for the actual elaboration must largely be upon associates, upon the few who have the training and the vast patience, and the access to herbaria and libraries, requisite for this kind of work, but above all upon my associate in the herbarium at Cambridge, to whom, being present with us, I will not further allude.

Of course we rely, very much indeed, upon the continued coöperation of all the cultivators of botany in the country; and it is gratifying to know that their number is increasing, new ones not less zealous than the old, and better equipped, are taking the places of those that have passed away, and some of them extending their explorations over the remotest parts of the land, and into districts where there is most to be discovered. All can help on the work, and all are doing so, by the communication of specimens and of observations. Those within the range of the pub-

Digitized by Google

lished manuals and floras get on — or should get on — with only occasional help from us. They should send us notes and specimens to any amount; but they should not ask us to stop to examine and name their plants, except in special cases, which we are always ready enough to take up. Those who collect in regions as yet destitute of such advantages may claim more aid, and we take great pains to render it; partly on our own account, that we may assort their contributions into their proper places, partly for the encouragement of such correspondents, who otherwise would not know what they have obtained, and who naturally like to know when they have made interesting discoveries.

But the scattered and piecemeal study of plants is neither very satisfactory nor safe. And it involves great loss of time, besides interrupting that continuity and concentration of attention which the proper study of any group of plants demands. As respects the orders of plants which are yet to be elaborated for the Flora, and as to plants which require critical study or minute examinations, necessarily consuming much time, it is better to defer their complete determination until the groups to which they severally belong are regularly taken in hand.

The coöperation of all our botanical associates is solicited in this regard, as a matter of common interest and advantage. For we are all equally concerned in forwarding the progress of the Flora of North America; and we may confidently expect from our botanical associates their sympathy, their forbearance, and their continued aid.

On the Position of the Gamopetalæ. By Lester F. Ward, of Washington, D. C.

[ABSTRACT.]

In 1789, Laurent de Jussieu, in his "Genera Plantarum," established the three "Divisions" of Dicotyledons, assigning the Apetalous Division the lowest place, the Monopetalous Division the second, or intermediate, place, and the Polypetalous Division the highest place in the series.

In 1848, Adrien de Jussieu, in his "Cours Eléméntaire de

Digitized by Google

Botanique," reversed the order of the second and third of these Divisions and gave his reasons therefor.

Notwithstanding this, nearly all subsequent authors have steadily adhered to the order established by Laurent de Jussieu, which is supposed to have been that of his uncle Bernard, the real founder of the "natural system."

This arrangement has, however, been severely criticised by Al. Braun and many others.

The present paper is designed to supplement an article "On the Natural Succession of the Dicotyledons" communicated by the writer to the "American Naturalist" for November, 1878, and to bring forward some evidence from statistics and from palæontology, as that did from organogeny, of the comparative *recency* of those plants having tubular, bell-shaped, or otherwise consolidated corollas, and thus to claim for that Division of the Dicotyledons — the *Monopetalæ*, or *Gamopetalæ*, as they are now more properly called — the highest place in the series, as did the younger Jussieu.

This is shown, first, by the great extent to which these plants are herbaceous as compared with those having the petals free (*Polypetalæ*) or with those destitute of petals (*Apetalæ*, or *Monochlamydeæ*).

From a comparison of seventeen floras, including those of the Eastern United States, of California, of Great Britain, of Italy, of the West Indies, etc., it is found that of the total Dicotyledons the Apetalous Division furnishes on an average 13.3 per cent, the Polypetalous Division 43.3 per cent, and the Gamopetalous Division 43.4 per cent; but when the shrubs, trees, and woody vines of each of these Divisions are alone considered, we find that the *Apetalæ* furnish about 24 per cent, the *Polypetalæ* over 43 per cent, and the *Gamopetalæ* only about 33 per cent. In some of the floras compared the percentage of this last Division is as low as 20.

A perhaps still more striking way of showing this is to see what proportion the *woody plants* of each Division bear to the total number in that Division; *e. g.*, of the *Apetalæ*, which in the flora of the Eastern United States form only 13 per cent of the total Dicotyledons, 42 per cent are woody, while of the *Gamopetalæ*, which form 47 per cent of the Dicotyledons, only 16 per cent are woody.

If trees only are taken into the account the contrast becomes

Digitized by Google

still stronger. In the last named flora, which is the largest of those compared, the *Apetalæ* constitute 38, the *Polypetalæ* 45, and the *Gamopetalæ* 17 per cent of the dicotyledonous trees.

These facts seem to show that the *Gamopetalæ* constitute a comparatively late type of vegetable growth which has not yet had time, as it were, to perfect itself and assume the frutescent and arborescent forms which mark the highest development, or phytological maturity.

In the second place, and in order to anticipate the possible objection that this might equally prove degeneracy, such as is seen in the Monocotyledons and in the Cryptogams, which, though known to be older types of vegetation, are, nevertheless, at the present time chiefly herbaceous, although once probably for the most part arborescent, the following palæontological evidence was adduced:

It was shown

1. That the first appearance of plants that are clearly referable to Gamopetalous genera is much later than that of either Apetalous or Polypetalous plants.

2. That the most abundant of those genera are such as in the living flora have very deeply lobed corollas, as in *Viburnum*, thus approaching the dialypetalous condition and strongly suggesting that at the time of their appearance they might not have been truly gamopetalous at all.

3. That the relative paucity of gamopetalous species is much more marked in fossil than in living floras.

4. That the lower the horizon, the greater the disproportion in this respect.

5. That in all collections the number of *specimens* of fossil is less than of living *Gamopetalæ* in proportion to the number of species; *i. e.*, there were then not only less numerous forms, but those that existed were less abundant.

These several propositions were supported by copious citations and by tubular exhibits compiled from Schimper's "Paléontologie Végétale," Heer's "Flora tertiaria Helvetiæ," Lesquereux's Cretaceous and Tertiary Floras of the United States, and other works, as well as by data obtained from the collections of fossil plants at the United States National Museum.

Digitized by Google

A REVISION OF THE GENUS CLEMATIS OF THE UNITED STATES. By JOSEPH F. JAMES, of Cincinnati, Ohio.

[ABSTRACT.[1]]

THE paper contains descriptions of all the species of Clematis native to the United States. Following the descriptions are remarks relative to them and the following changes are suggested in the nomenclature. *Clematis ovata* Pursh is reduced to a synonyme of *C. ochroleuca* Aiton; *C. Fremontii* Wats, is reduced to a variety of *C. ochroleuca* Ait.; *C. coccinea* Engelm. is referred back as a variety of *C. Viorna* L.; *C. Pitcheri* Torr. and Gr. is considered a variety of *C. Viorna* L.; *C. Catesbyana* Pursh and *C. pennsylvanica* Donn are considered synonymes of *C. virginiana* L.; *C. holosericea* Pursh is considered var. *bracteata* D. C. of *C. virginiana* L. Following the descriptions is given the geographical distribution of each of the species, and after this remarks on the probable place of origin of some of the species. The paper concludes with a synonymy of the species.

ACHENIAL HAIRS AND FIBRES OF COMPOSITÆ. By G. MACLOSKIE, of Princeton, N. J.

[ABSTRACT.[2]]

THE surface of the achenes, the character of their hairs, and their internal structure, are used to indicate the affinities of the suborders, according to the following tabular scheme.

I. Vernonieæ; as in Asteroideæ.

II. Eupatorieæ; "

III. Asteroideæ; achenes bearing duplex hairs, which are usually bifurcate at tips, acute, and often unequal. They have no elaters. Hairs sometimes few or obsolete; but even in such cases rudiments of duplex hairs may occur. Some are as in Inuloideæ.

IV. Inuloideæ; duplex hairs, usually obtuse and equal. No elaters.

V. Helenioideæ; as in Asteroideæ. Crystalloids occur in the endocarp.

VI. Anthemideæ; achenes usually glabrous: but having per-

[1] Printed in full in Jour. Cincinnati Soc. Nat. Hist., Vol. vi, July, 1883.

[2] Published in full, with illustrations, in the AMERICAN NATURALIST for Jan., 1883.

Digitized by Google

icarp-cells with spiral filaments (Achillæa has internal glands in pericarp-cells.)

VII. Senecionidæ; duplex hairs, having divisions equal, with elaters on filaments which escape when moistened.

VIII. Calenduleæ; probably as in Senecionidæ (in some cases with multicellular hairs interposed).

IX. Arctotideæ; as in Asteroideæ.

X. Cynaroideæ; some (*Carlina*, *Xeranthemum*) as in Asteroideæ; some (*Cnicus*, etc.) as in *Cichorieæ*. Some have simple hairs of perianth encroaching on achene (*Arctium*, *Centaurea*, *Echinops*).

XII. Mutisieæ; as in Asteroideæ.

XIII. Cichorieæ; achenes glabrous, with denticulate epidermal cells. Endocarp having filaments enclosing crystalloids. These by pressing the seed-vessel of dandelion cause it to dehisce and protrude the seed.

These observations suggest a somewhat different line of affinities from that usually adopted. The Asteroid group should include most of the suborders. Anthemideæ are misplaced: and the tribal unity of Cynaroideæ is questionable, one section of its genera agreeing as to their achenes with Cichorieæ.

Some Observations on the Action of Frost upon Leaf-cells.

By C. E. Bessey, of Ames, Iowa.

[ABSTRACT.]

The severe frosts of May 22 and 23, 1882, in Central Iowa, gave me the opportunity of making some important observations on the action of frost upon the cells of the young leaves of certain trees. The leaves of the Green Ash (*Fraxinus viridis*) were just developing, and were in that tender state peculiar to such young structures. Many of the leaflets were entirely killed, while perhaps the great majority were simply blackened, that is, they were killed near the apex, while toward the base they were still alive.

The examination of thin sections of these browned leaves soon after the frost, say within forty-eight or sixty hours, showed that the cells were differently affected by the low temperature. Instead of all the cells being equally injured, some were found to be dead,

Digitized by Google

and in these the protoplasm was brown and shrunken; in others the contents showed more or less of injury by a greater or less coagulation of the still green protoplasm; others, again, appeared to be scarcely injured.

The disappearance of the chlorophyll granules, as distinct bodies, was one of the most common phenomena in the less injured cells. In many cells, which apparently were still alive, the colored protoplasm appeared to have retracted itself from the outer cell walls, toward the inner part of the cell, that is, the part of the cell lying toward the interior of the leaf. This was more particularly noticeable in the palisade cells of the leaf section.

Some of these leaves were affected by the Ash-leaf Rust, the so-called *Æcidium fraxini* of Schweinitz, forming small orange-yellow spots in the parenchyma or the fibro-vascular bundles of the ribs. The leaf-tissues are always thickened in these spots so that the thickness of the leaf in them is double or treble that in the normal portions. Under the microscope the tissues of the spots are seen to be penetrated by ramifying hyphæ of the parasite, which also extend for some distance into the surrounding, still green, tissues.

After the frost, I noticed within a few hours, that the cells immediately surrounding the orange spots were somewhat translucent, giving early evidence of their having been more injured than the adjacent outer tissues. Upon waiting a day or two, I observed that these translucent cells turned black and began to decay. Sections made both in the earlier and later stages showed that in this surrounding belt of cells the protoplasm had been much more severely injured than in those lying farther away from the spots.

The observations here recorded appear to indicate that in many plant cells there is the power of resisting (however slightly) the injurious effects of low temperature, and that in this respect there is a difference between cells which occupy, so far as we may see, similar positions, and which are equally exposed to the action of the frost. Moreover, it appears to be demonstrated that the lowering of the vitality of cells, as by the presence of parasitic hyphæ, lowers, also, their power of resisting low temperature.

The importance of these observations consists in furnishing *experimental* proof of the power of living plant cells to resist destruction by low temperature; hitherto the doctrine has been held on theoretical grounds mainly.

Digitized by Google

THE MOTIONS OF ROOTS AND RADICLES OF INDIAN CORN AND OF BEANS. By W. J. BEAL, of Lansing, Mich.

C. DARWIN showed that a piece of gummed paper on one side of the tip of a root in damp air caused it to bend out of its course. At the Cincinnati meeting I showed that roots in damp air often made coils without anything being placed on the tips. In germinating some 700 kernels of yellow dent corn in the soil, not one root made a coil. The roots seldom made very abrupt turns in any direction.

In a cool, damp cellar in August, kernels of Indian corn were planted with one end uppermost and the surface of sand pressed down smooth. They were placed in sand about three-fourths of an inch below the surface. The plumules all turned up and came out of the soil. Primary and secondary roots came out of the sand and often run along on the surface for a foot or more. The roots often entered the sand again after coming out. When planted with the *apex* of the kernel uppermost, secondary roots came out most numerous; often two or three to each plant. When planted with the radicle end uppermost the primary root often came out of the ground. Of 150 kernels with the radicle end down three sent the primary root out of the sand.

Of 181 kernels where the radicle was planted uppermost, eighty-nine sent primary roots out of the sand. Whether out of the sand or in it, the primary roots for a foot or more always kept ahead of the secondary roots. The roots apparently grew just as well out of the sand as when beneath the surface. Those above the soil soon became red. When planted in sandy soil, in open garden, with radicle down, secondary roots often came to the surface, where they perished. When planted with the tips or radicles uppermost, about ten per cent sent the primary root out of the soil.

Lima beans planted with the hilum down all came up well. After some time many seeds of Lima beans with the hilum uppermost sent some portion of the germinating plant out of the ground. Five out of eighty seeds soon perished when planted in the cellar with the hilum uppermost.

In the open garden, nine out of twenty-five sent the roots and lower end of plumule out of the soil, when the seeds were planted with hilum uppermost. These seedlings soon perished.

Digitized by Google

Observations on the Fertilization of Yucca and on structural and anatomical Peculiarities in Pronuba and Prodoxus.

By C. V. Riley, of Washington, D. C.

[ABSTRACT.]

This paper records some recent experiments and observations which establish fully and conclusively the fact that Pronuba is necessary to the fertilization of the capsular Yuccas. It describes for the first time how the pollen is gathered and collected by the female Pronuba. The act is as deliberate and wonderful as that of pollination. Going to the top of a stamen she stretches her tentacles to the utmost on the opposite side of the anther, presses the head down upon the pollen and scrapes it together by a horizontal motion of her maxillæ. The head is then raised and the front legs are used to shape the grains into a pellet, the tentacles coiling and uncoiling meanwhile. She thus goes from one to another until she has a sufficiency.

My observations confirm the accuracy of Dr. Geo. Engelmann's conclusion as to the impotence of the stigmatic apices in some of the Yuccas and show how the apparently contradictory experience of Mr. Meehan can be reconciled on variation in this respect in the species of the same genus. The exceptional self-fertilization in *Yucca aloifolia* — the only species in which it is recorded — is shown to be due to the fact that in the fruit of this species, there is no style, the stigma being sessile and the nectar abundant, filling and even bulging out of the shallow opening or tube. The flowers are always pendulous and the pollen falling from anthers, under favorable circumstances, readily lodges on the nectar.

The irregularity in the shape of the fruit of the Yuccas — considered a characteristic by botanists — is proved by experiments to be due to the punctures of Pronuba.

The egg of Pronuba which averages 1.5 mm. long, having a swollen apical end and a long and variable pedicel is passed into the ovarian cavity. The puncture is made usually just below the middle of the pistil on the deeper depression which marks the true dissepiment, or through the thinnest part of the wall. The horny part of the ovipositor reaches the longitudinal cavity at the external base of the ovule near the funiculus, without, as a rule, penetrating or touching the ovule itself, and the delicate and extensile oviduct then conveys the egg for some distance (the length of six or eight ovules) along the cavity, the terminal portion of the oviduct being

Digitized by Google

furnished with retrorse hairs which help to hold it in place during the act.

The paper concludes with some studies of the internal anatomy of Pronuba and Prodoxus.

THE HIBERNATION OF ALETIA XYLINA (SAY), IN THE UNITED STATES A SETTLED FACT. By C. V. RILEY, of Washington, D. C.

[ABSTRACT.]

I HAVE already shown in previous remarks before the Association that there were various theories held by competent men — both entomologists and planters — as to the hibernation of this Aletia (the common cotton worm of the south); some believing that it hibernated in the chrysalis state, some that it survived in the moth state, while still others contended that it did not hibernate at all in the United States. I have always contended that the moth survived within the limits of the United States, and in this paper the fact of its hibernation, principally under the shelter of rank wire-grass, is established from observations and experiments made during the past winter and spring. The moth has been taken at Archer, Fla., during every winter month until the early part of March when it began to disappear, but not until eggs were found deposited. The first brood of worms was found of all sizes during the latter part of the same month on rattoon cotton, while chrysalides and fresh moths were obtained during the early part of April.

The fact thus established has this important practical bearing:

Whereas, upon the theory of annual invasion from some exotic country there was no incentive to winter or spring work looking to the destruction of the moth, there is now every incentive to such action as will destroy it either by attracting it during mild winter weather by sweets, or by burning the grasses in which it shelters. It should also be a warning to cotton growers to abandon the slovenly method of cultivation which leaves the old cotton stalks standing either until the next crop is planted or long after that event, for many planters have the habit of planting the seed in a furrow between the old rows of stalks. The most careful recent researches all tend to confirm the belief that Gossypium is the only

Digitized by Google

plant upon which the worm feeds within the cotton belt; so that in the light of the facts presented there is all the greater incentive to that mode of culture which will prevent the growth of rattoon cotton, since it is questionable whether the moth would survive long enough to perpetuate itself upon newly sown cotton except for the intervention of the rattoon cotton.

Emulsions of Petroleum and their value as Insecticides. By C. V. Riley, of Washington, D. C.

[ABSTRACT.]

The value of petroleum for the destruction of insects has long been recognized and I have for years been endeavoring to solve the question of its safe and ready use for this purpose without injury to plants. The paper contains the results of extended experiments carried on under my direction, by several of my assistants and particularly by Prof. W. S. Barnard, Mr. Jos. Voyle of Gainesville, Fla., Mr. Clifford Richardson, assistant chemist of the Department of Agriculture, and Mr. H. G. Hubbard, who has for over a year been devoting his time to practical tests in orange groves at Crescent City, Fla.

Passing over the ordinary methods of oil emulsions by phosphates, lactophosphates and hypophosphites of lime and various mucilaginous substances, experience shows that, for the ordinary practical purposes of the farmer and fruit-grower, soap and milk are among the most available substances for the production of petroleum emulsions.

Ordinary bar soap scraped and rubbed into paste at the rate of 20 parts soap, 10 parts water, 30 parts kerosene and 1 part of fir balsam, will make, when diluted with water, an emulsion stable enough for all practical purposes, as the slight cream which in time rises to the surface, or the flakiness that often follows is easily dissipated by a little shaking. Soap emulsions are, however, less satisfactory and efficient than those made with milk. Emulsions with milk may be made of varying strength, but one of the most satisfactory proportions is 2 parts of refined kerosene to 1 part of sour milk. This must be thoroughly churned (not

Digitized by Google

merely shaken) until a butter is formed which is thoroughly stable and will keep indefinitely in closed vessels and may be diluted *ad libitum* with water when needed for use. The time required to bring the butter varies with the temperature and both soap and milk emulsions are facilitated by heating the ingredients. Ordinary condensed milk may also be used by thoroughly stirring and beating it in an equal or varying quantity of kerosene.

The diluted emulsion when prepared for use should be finely sprayed upon the insects to be killed, its strength varying for different insects or plants and its effect enhanced when brought forcibly in contact with the insects.

Of mucilaginous substances, that obtained from the root of *Zamia integrifolia*, a plant quite common in parts of Florida, and from the stems of which the Florida arrowroot is obtained, has proved useful as an emulsifier.

These petroleum emulsions have been used with success by Dr. J. C. Neal, of Archer, Fla., against the Cotton Worm, without injury to the plant, but their chief value depends on their efficacy against the different scale-insects which affect Citrus plants. Experience so far shows that such plants do not suffer from its judicious use, but that it must be applied with much more care to most deciduous fruit trees in order not to injure them.

A new Sexual Character in the Pupæ of some Lepidoptera.

By J. A. Lintner, of Albany, N. Y.

[ABSTRACT.]

The sexual character of insects have always been of much interest to entomologists, even when, as in most insects, they are well-marked, and much more so when they are quite obscure and only to be discovered by study and comparison.

Many of the features seem to be directly dependent upon sex, while others apparently serve no special purpose. A number of these are mentioned in the paper.

It would not be expected that sexual features should be as numerous and as marked in the earlier stages of insects as in the final stage. We find them rarely in eggs. Sex clearly exists in

Digitized by Google

the larval stage, although it is but seldom shown in external characters. The caterpillar of *Thyreus Abbotii* is generally believed to show distinct sexual forms.

I have heretofore pointed out sexual characters in the anal segment of some *Sphingidæ*. In this paper attention is called to a very interesting feature indicating the sexes of the pupæ of the *Cossinæ*, and of such *Ægeridæ* as have been examined. These species, living as larvæ and pupæ in the interior of plants and trees, are provided with a pupal armature of two transverse rows of teeth or spines upon most of the abdominal segments, which serve, at their time of final transformation, to release them from their burrows and partially to extrude them from the trunk.

In the male, the tenth segment (not counting the head as one), or the antepenultimate, *is furnished with two rows of teeth, while the female uniformly has but one* (as have the two following segments in each sex).

Another interesting feature of this armature is, that it discloses excellent characters for the determination of species.

On an Egg-parasite of the Currant Saw-fly, Nematus ventricosus. By J. A. Lintner, of Albany, N. Y.

[ABSTRACT.]

In the twelfth Report of Dr. Fitch on the Insects of New York, he refers to the discovery of this interesting and efficient parasite made by me at Utica, N. Y., in the year 1866. Two years later, at Schoharie, N. Y., I again collected the insect, and by confining individuals in a glass supplied with newly deposited eggs of the currant-fly was able to observe the manner of its oviposition, placing two or three of its eggs within one of the currant-fly.

The specimens then obtained were destroyed before they could be satisfactorily studied and determined. From that time until the present year (1882) no more examples could be found although meanwhile faithfully sought for.

In June last, it was rediscovered in my garden at Albany, N. Y., and from another garden in the same city, a large number of leaves were collected bearing the parasitized eggs of the currant-fly,—

Digitized by Google

at once recognized by their brown shades in their early stage, and by the pupal form later.

Packages of the egg-bearing leaves (containing from two hundred to three hundred eggs each) were at once made up, and sent to entomological friends in several of the States and Canada, with the request that they be pinned upon currant bushes containing eggs of the currant-fly, in the hope that the valuable parasite might thus be extensively and more rapidly distributed than if left to its natural distribution. Several parasites of other insects have already been distributed in this manner, and it is hoped that the present effort will prove to be successful, and aid in checking the ravages of this well-known and great pest of our gardens.

The specimens of the parasite obtained by me — exceedingly minute insects, barely exceeding the hundredth of an inch in size and belonging to the family of Chalcididæ — prove to have been described by Professor Riley recently, in 1878, as *Trichogramma pretiosa*. It had been obtained by him from eggs of the cotton-worm moth, *Aletia argillacea*, collected in the southern states. Another species of the genus, *T. minuta*, parasitizes the eggs of one of our butterflies, *Limenitis dissippus*.

OBSERVATIONS ON THE ELM-LEAF BEETLE, GALERUCA XANTHOMELÆNA. By G. MACLOSKIE, of Princeton, N. J.

[ABSTRACT.]

ITS ravages at Princeton 1880–1882. The adult winters in cellars and attics of houses: comes out early in May: ovipositing: form and development of ova. The larva described and its habits. The pupa, its form and habit of lying concealed in crevices of bark and about the base of trees. Coming-out of the beetles: their forms and habits: ¼ inch long, with orange elytra having two longitudinal black bars. Sucker-bristles on tarsus: heart seen beating through scutellum: mode of folding wings (1) longitudinally along main ribs (2) obliquely at the tip (3) obliquely at internal angle near base. The folding effected by the tension of the elastic chitine.

Digitized by Google

Powers of flight moderate (slow progress in extending to new localities).

Second course of eggs on second crop of elm-leaves. Probably three broods in the season.

Damage to the trees. Efforts to counteract this, (1) by destroying beetles in their winter refuge, (2) by kerosene on the bark of the trees (it kills leaves) when the larvæ are travelling, (3) by collecting and destroying the pupæ while changing, (4) by entrapping the beetles with old carpets, etc., (5) by sprinkling with London purple (1 lb. in 100 gallons of water). This mode is recommended by C. V. Riley.

No advantage from wrapping the stems in tarred cloth nor from leaving lighted lamps near the trees at night.

On the Gall-mites, Phytoptus. By Wm. A. Buckhout, of State College, Pa.

[ABSTRACT.]

In the spring, galls caused by Phytopti may be found upon the leaves of the white maple as soon as they have expanded, and a careful examination shows the galls in process of formation while the leaves are still folded within the bud. The mites are upon the outer, *i. e.*, the under sides of the leaves, which when in the bud are very hairy. The irritation caused by the mites produces an abnormal multiplication of vegetable cells and the gradual arching upward of that part of the leaf, thus making a gall which differs from the galls produced by insects in that it has an opening below, which is frequently lined with hairs. Though generally on the upper surface of the leaf they are sometimes on the lower. These result from stray mites that have worked their way around to the upper side. The gall is always on the side opposite to that upon which the mite begins its attack. Each gall contains at first but one mite. The galls enlarge with the leaves and white globular eggs appear. A gall eventually becomes tenanted by a large number of mites. These migrate to all parts of the tree. Some produce (generally on the under side of the leaf) the growth of hypertrophied hairs called Erineum. The mites live and

Digitized by Google

breed in this growth as they do in the galls. Later they seek winter quarters, and may be found in the crevices of the bark in the maple, and between the scales of the buds in the pear. The hairiness of the bud scales of many trees makes detection of such small objects as gall-mites very difficult.

The gall-mites when fully grown are of a narrow cylindrical form and average $\frac{1}{4}$ to $\frac{1}{5}$ mm. long. All variations in size can be accounted for by difference in the age of different individuals, and by the ease with which they change form. There are two parts to the body, cephalothorax and abdomen; the latter is minutely striated, the former smooth, and bears the legs and mouth appendages.

The mouth parts are a pair of blunt pointed mandibles held closely together, between which is a blunt body, perhaps the maxillæ, generally retracted, but occasionally protruded.

Eyes are wanting. The legs are four, placed far forward, close together, and alike in size and shape. Each leg is five-jointed, the second joint the longest. There are one or two curving bristles at certain joints. The terminal joint is made up of a finger-shaped process to which is opposed a feather-like body of extreme tenuity having a central rachis and five barbs.

The abdomen comprises seven-eighths of the body, is closely striated, and very uniform except at the free extremity which is smooth and sucker-like. There are seven pairs of bristles attached to the body; one pair at the base of the second pair of legs, one pair on the back anteriorly, two pairs on the side of the abdomen anteriorly (but at slightly different planes), one pair on the side of the abdomen posteriorly, one pair long, and one pair short, anal bristles; each bristle grows from a small tubercle.

There is a large clear space in the anterior part of the body cavity of an adult and behind it are two great masses of eggs, lying close to the abdominal walls, leaving a more or less clear central channel. In its hermaphrodite character the resemblance of Phytoptus to the Tardigrades is very marked, although the testes have not been made out. In external form there is resemblance to Demodex and Pentastoma.

The gall mites walk with considerable ease using the legs as an ordinary quadruped does.

The gall mites are adult, and have no further change.

In all the galls and abnormal growths examined by me, the

Digitized by Google

mites were essentially the same, and no difference worthy of being ranked specific can be found.

The blister spots of the pear and the malformed flower clusters of the black ash, while not technically galls, are abnormal growths caused by peculiarities resident in the plants themselves, and not in the mites.

The cases in which gall mites were found upon berries of the grape where they bred in the minute roughened and cracked spots in the pedicels, no galls, erineum or malformation being produced anywhere in the vicinity, make plain the fact that galls are not the necessary sequence of the presence of these mites, but that so-called gall-mites are widely scattered over the cellular tissue of plants in which they may produce malformations of various kinds, or none at all, according to circumstances.

The following is a list of the trees and plants on which mite-galls and other malformations caused by Phytopti have been found by me.

1. White Maple (*Acer dasycarpum*)
   a. galls, irregularly rounded, inner wall roughened by protuberances, medium sized (3–5 mm.)
   b. erineum, crimson, under side of leaf.
2. Red Maple (*Acer rubrum*)
   a. galls, reddish, rounded, small (1–2 mm.)
   b. erineum, crimson, under side of leaf.
3. *Sugar Maple* (*Acer saccharinum*)
   galls elongated (3–5 mm. long), pointed, interior roughened.
4. Black Cherry (*Prunus serotina*)
   galls, large (5–8 mm. long), obovate, tapering to a narrow stem, generally curved, and splitting lengthwise.
5. Wild Yellow Plum (*Prunus Americana*)
   galls as in *P. serotina* but smaller, more slender.
6. Cultivated Pear (*Pyrus communis*)
   "Blister spots," at length blackened.
7. Linden (*Tilia heterophylla*)
   galls, elongated, pointed (3–5 mm.) interior densely covered by long, curved unicellular hairs.

Digitized by Google

8. Black Ash (*Fraxinus sambucifolia*)
   flower clusters, malformed, producing a cauliflower-like mass.
9. Willow (*Salix*———sp.)
   galls, small, numerous, clustered, reddish.
10. American Beech (*Fagus ferruginea*)
   erineum, yellow, upper side of leaf (but one specimen examined).
11. Poison Ivy (*Rhus toxicodendron*)
   galls, small, numerous, clustered.
12. Button Bush (*Cephalanthus occidentalis*)
   galls, small, numerous, clustered along the veins.
13. Sour Gum (*Nyssa multiflora*)
   galls, small, numerous, clustered, becoming corky.
14. Yellow Birch (*Betula lutea*)
   erineum, reddish green, upper side of leaf (but few specimens found).
15. Red Birch (*Betula nigra*)
   galls, small, numerous, rounded, interior smooth or slightly granular.
16. Speckled Alder (*Alnus incana*)
   galls, small, rounded, reddish.
17. American Elm (*Ulmus Americana*)
   galls, medium sized, elongated, cylindrical, curved, interior filled with long, curved, unicellular hairs.
18. Cultivated Grape (*Vitis*———sp.)
   slight protuberances of the pedicels of the berries shelter colonies of gall-mites, which wander over the whole vine.
19. Hornbean (*Ostrya Virginica*)
   galls, small, numerous, rounded.
20. European Alder (*Alnus glutinosa*)
   galls, small, rounded, reddish.

A few leaves were received from Finland, through Mr. Franklin B. Hough.

Digitized by Google

On the Mouth of the Larva of Chrysopa. By Wm. Saunders, of London, Ont., Canada.

[ABSTRACT.]

The author refers to the form and tubular character of the jaws, the manner in which the chrysopa larva seizes and holds its victims, the aphides, and its method of feeding as seen under the microscope.

At the base of each of the mandibles the integuments are dilated into a sac-like form capable of expansion and compression at will, a portion of the thorax is similarly constructed and it is by the repeated dilating and compressing of these sacs that the fluid contents of the body of an aphis is transferred through the tubular mandibles to the stomach of the chrysopa larva.

The Classification of the Ungulata. By Edward D. Cope, of Philadelphia, Pa.

[ABSTRACT.]

The name Ungulata was used in this paper for the placental mammalia with enamelled teeth, which are furnished with hoofs. Thus defined, it includes the existing groups Artiodactyla, Perissodactyla, Proboscidia and Hyracoidea; and the Amblypoda, Toxodontia and Condylarthra of extinct types. The material of the latter groups now known enables us to understand some of the primary characters of the orders and to perceive the reason of the order of their appearance in time.

Especial attention was devoted to the arrangement of the bones of the carpus and tarsus. Two types of carpus can be recognized. In the first, the trapezoides supports the scaphoid exclusively; in the second, it supports the lunar also. In the first, the magnum supports the lunar, in the second it supports a part of the cuneiform also. To the former type belong the Condylarthra, the Proboscidia, the Amblypoda and the Hyracoidea; to the latter the Perissodactyla and the Artiodactyla.

In the tarsus, three divisions are also easily distinguished. In the first the astragalus articulates only with the navicular, and the

Digitized by Google

cuboid with the calcaneum only. This includes the Condylarthra and the Hyracoidea. In the second, the astragalus unites with the navicular only, and the cuboid with the navicular and the calcaneum. This includes only the Proboscidians. In the third division, the astragalus unites with both cuboid and navicular, and the cuboid with the astragalus and cuboid. Here come the Amblypoda, the Perrissodactyla, and the Artiodactyla. Collating the relations of both carpus and tarsus, we have then four divisions, each characterized by peculiarities as above indicated. The nomenclature of these divisions it was proposed should be as follows:

Order I. TAXEOPODA; suborders *Hyracoidea* and *Condylarthra*.
Order II. PROBOSCIDIA.
Order III. AMBLYPODA; suborders *Taligrada*, *Pantodonta* and *Dinocerata*.
Order IV. DIPLARTHRA; suborders *Perissodactyla* and *Artiodactyla*.

The Amblypoda is the only one of these orders which has no recent representatives. The Condylarthrous division of the Taxeopoda is the oldest group.

The order of evolution has been as follows: in the Taxeopoda the relations of the carpal and tarsal bones are in separate continuous series. In the Proboscidia and Amblypoda, the carpal series is linear, and the tarsal series alternating, but in different ways. In the Diplarthra the carpal and tarsal bones alternate with each other in the longitudinal direction, or form oblique series. It is evident that the alternating series form the most compact and effective structure, resisting strains much more strongly than that of the order Taxeopoda, or the linear arrangement. In the Proboscidia, we have the weaker structure of the forefoot, and a peculiar but stronger one of the posterior foot. In the Amblypoda we have partly the same structure of the forefoot, while the posterior foot has the interlocking character of the hinder foot of the Diplarthra.

Three points are here to be observed. I. That the weaker structure of the carpus and tarsus appears first in time. II. That the stronger structure appeared first in the posterior limbs. III. That the interlocking structure has greatly multiplied, while the linear has dwindled and mostly disappeared. Here is a direct connection between mechanical excellence and survival.

Digitized by Google

The appearance of the alternating type first in the posterior foot, is a fact parallel to the reduction of the toes in the hind foot earlier in time than in the fore foot. This I have suggested has been due to the greater force of the impacts and strains of the hind foot than the fore foot, since it is the limb which propels the body, while the anterior limb principally supports. The reduction of both fingers and toes has commenced on the inner side, and the second row of carpal bones has coincidentally with this event, been rotated inwards, with the obvious effect of giving a more alternating position to the digits. The change in the tarsus has been effected by the inward extension of the cuboid, which also gives greater support to the external, and subsequently to the penultimate toe.

THE FAUNA OF THE PUERCO EOCENE. By EDWARD D. COPE, of Philadelphia, Pa.

[ABSTRACT.]

THE paper on the fauna of the Puerco Eocene epoch included a general account of fifty species, mostly mammalia, of the oldest tertiary formation known. The author said he discovered the formation in 1874, in N. W. New-Mexico, and that in 1876 it had been observed by Endlich and Holmes in southern Colorado. Its deposits reach a depth of 1000 feet, and consist of marls divided by beds of sandstone.

Of Reptilia, six species only had been found, one tortoise, one crocodile, and three species of Champsosaurus. The latter genus forms a peculiar suborder probably of Lacertilia (lizards), and is characteristic of the underlying Laramie or Cretaceous No. 6 of America, and has been obtained from the lowest Eocene of Reims, France. The species were aquatic, according to Lemoine.

The Mammalia present many peculiarities. The Rodentia, Carnivora, and all the existing orders of Ungulata are wanting, and their place is taken by Marsupialia, Bunotheria and the ungulate suborders Condylarthra and Taligrada.

Five species of Marsupials have been found, which are partly related to the Plagiaulax of the Jurassic, to the Pliocene Thylacoleo, and existing kangaroos of Australia. The most remarkable are the two species of Ptilodus, a genus which has also been found in France with the Champosaurus. *Catopsalis pollux* was larger than any existing kangaroo.

Digitized by Google

Of the supposed Bunotheria, some may be Marsupialia. They include two species of lemuroids, seven species of Creodonta (flesh-eaters) two of Tillodonta, one of Tæniodonta and two of Insectivora. The lemuroids (*Adapidæ*) belong to genera of the Wasatch epoch, while of the creodont genera, only one (*Didymictis*) belongs to that epoch, and three are peculiar. One of these is Sarcothraustes, which represents the flat-clawed group of the Wasatch and included a large powerful species (*S. antiquus*) as large as a black bear. Deltatherium and Triïsodon are very opossum-like Creodonta. The Tillodonta belong to the genus Psittacotherium, which is provided with four powerful cutting rodent-like incisors in the lower jaw. It was a nutcracker or bark stripper. Of the insectivora, Conoryctes with two species is the peculiar genus.. It has well developed canines, and probably lived on hard substances.

The suborder Condylarthra is found only in this formation and in the Wasatch, and is represented in the Puerco by two families, the Phenacodontidæ and Meniscotheriidæ and twenty-five species. The former family has simply tubercular, the latter crested teeth. The suborder is more nearly allied to the Hyracoidea (conies) of Asia and Africa, than to any other, and with that and probably some other groups should be combined in a special order, the Taxeopoda, which differs alike from its nearest allies, the Amblypoda and the Proboscidia. Besides Meniscotherium and Phenacodus, there have been referred to this order six genera with eleven species, which are only known from jaws and teeth. Some of these have some of the cusps of the inferior molars compressed, so as to serve the sectorial function of a flesh-eater. This is especially the case with *Haploconus*. Periptychus was at first supposed to be a creodont. It has the teeth remarkably sculptured. *Pantolambda bathmodon*, the size of a sheep, is the largest species, and is an aberrant Amblypod.

In review, it appears that of the fifty known species of the Puerco epoch, all are peculiar to the formation. Three belong to a genus of the Laramie epoch. Ten belong to six genera which are also found in the Wasatch epoch. One (*Hyopsodus*) ranges to the Bridger. Of the sub-orders only two (*Marsupalia*, *Insectivora*) still exist, and three, including eighteen species, are not found above the Eocene. Two other Eocene sub-orders are represented by a very few species in the lowest Miocene.

Digitized by Google

On a Recent Species of Heteropora from the Strait of Juan de Fuca. By J. F. Whiteaves, of Ottawa, Ontario.

The genus *Heteropora* was constituted by De Blainville in 1830, for the reception of certain erect and more or less branching Polyzoa, whose calcareous skeleton is composed essentially of slender tubes of comparatively large size, each of which is surrounded by a single row of smaller ones. The larger tubes, which are usually circular in section, are universally admitted to represent the polyp-cells proper, — but the functions of the smaller ones, which Mr. Busk calls the interstitial canals and which are often angular in section, are by no means clearly understood. It has been ascertained, too, that the smaller tubes at least are provided with cross partitions, that both kinds are furnished with radiating spines, and that the walls of both are perforated by numerous openings. These cross partitions and radiating spines have been held to be the homologues of the tabulæ and septa of the tabulate corals and the perforations in the walls of the tubes as analogous to the mural pores of the Favositidæ.

Lindstrom, in 1876, maintained that the Palæozoic fossils known to geologists under the names *Chætetes*, *Stenopora* and *Monticulipora* have almost exactly the same kind of internal structure as *Heteropora*, and that the former genera therefore should be removed from the class to which the true anthozoan corals belong and placed in that of the Polyzoa, a conclusion which had been arrived at ten years before by Dr. Rominger.

Many species of *Heteropora* have been described from the Mesozoic and Tertiary rocks of Europe and the United States, but no living representatives of the genus had been discovered until 1879. In that year Mr. Waters described and figured a recent species from Japan, under the name *H. pelliculata*, in the Journal of the Royal Microscopical Society, and a little later in the same year Mr. Busk published a diagnosis, with illustrations, of a living polyzoon from New Zealand, which he called *H. Neozelanica*, in the Journal of the Linnean Society. Mr. Waters and Dr. H. A. Nicholson, however, are both of the opinion that the *H. Neozelanica* is identical with the previously described *H. pelliculata*.

On the coast west of Sooke, Vancouver Island, in the Strait of Juan de Fuca, Mr. James Richardson, late of the Geological Survey of Canada, found a single specimen of a recent calcareous polyzoon,

Digitized by Google

in 1874, which, in the writer's judgment, cannot be distinguished by any tangible character from the Japanese and New Zealand species of *Heteropora* described by Messrs. Waters and Busk. No thin sections of this specimen have been made to show the minute structure of the interior, but the whole of the outer surface has been carefully examined under the microscope and camera drawings have been made of some of the appearances thus presented. The punctured calcareous pellicle which Mr. Waters represents in his figures as closing the mouths of the interstitial canals in *H. pelliculata*, and to which the specific name refers, can be well seen in the Canadian specimen. On other portions of the latter the apertures of the larger tubes project distinctly beyond the general level of the surface, a feature which is not indicated on any of Messrs. Waters' or Busk's illustrations, but this slight variation from their types can scarcely be held as indicating a specific divergence or difference from them.

On the Habits of Cryptobranchus. By Burt G. Wilder, of Ithaca, N. Y.

[ABSTRACT.]

Living examples of Cryptobranchus have rarely been brought to this country, and the following observations may be worth recording even if they merely confirm those of Dutch and German writers, whose works I have not yet been able to consult.

This specimen is about 75 cm. (two and one-half feet) long, and was obtained for Cornell University through Prof. H. A. Ward, who brought it by hand from Japan.

It is very sluggish, remaining quiet for hours in the water, excepting for the periodical respiratory movements presently to be described. Nevertheless, it can display considerable activity, and on one occasion escaped from a common wash-tub which was about 30 cm. (one foot) deep. Out of water it appears uncomfortable and crawls first in one direction and then in another, with frequent stoppages. It evidently seeks the shade, but gives no sign of discriminating objects, walking against dogs and cats and people as against wood or stone. The trunk is never lifted from the ground, and the compressed tail rests upon one side, but the head and neck are sometimes raised.

The respiratory actions in deep water I have not observed

Digitized by Google

accurately; in shallow water just covering it, the nostrils are raised above the surface at frequent intervals, a hissing sound is heard, and after the nostrils are again carried below the surface, a few bubbles of air escape therefrom, and there are muscular movements about the neck. During an hour, in freshly changed water, these respiratory motions occurred at intervals varying from half a minute to twelve minutes, but usually the time was from two to four minutes.

No notice is taken of raw or cooked beef or fish, either floating at the surface, lying at the bottom or suspended just above the water. But if bits of food are dropped close to the mouth, or allowed to slide over the top of the head or held at the lips they are readily snapped up and swallowed if not too large. After a time, the head was moved slowly toward meat held about 1 cm. from the lips; I could not determine whether sight or smell were the sense concerned. Neither have I ascertained the functions of the tubercles.

This specimen has now eaten the following: beef heart, raw and boiled; blue-fish, raw and boiled; hard boiled white of egg; canned roast beef; raw lambs' liver, heart, diaphragm, lung and thymus; baked maccaroni.[1]

THE PLACENTAL DEVELOPMENT IN MAMMALS: A UNITY OF ANATOMICAL AND PHYSIOLOGICAL MODALITY IN ALL VERTEBRATES.

By HENRY O. MARCY, of Boston, Mass.

[ABSTRACT.]

RECENT investigations by a number of distinguished scholars have given this subject a new and exceptional interest. Deductions have been formulated of fundamental importance not only to the physician and the pathologist, but also to the comparative anatomist and scientist. The text-books repeat almost unchanged the teachings of twenty years ago. The value of comparative an-

[1] According to Prof. D. S. Jordan, the prior generic name of the great Japanese salamander is *Megalobatrachus*. *Menopoma* should be replaced by *Cryptobranchus* and *Menobranchus* by *Necturus*.

The subject of this abstract died May 25, 1883. Beside the skin and skeleton, preparations of the brain, heart and other viscera are preserved in the museum of Cornell University.

Digitized by Google

atomy in clearing up intricate questions pertaining to the structures of the human species has been generally underestimated; especially is this true in reference to the human placenta. The older masters of the Italian schools (Phillipo Ingrassius, Fabricius, Malphigi) studied with great care many phases of placental development in mammals. The modern investigations of Owen, Huxley, Turner and especially of Prof. Ercolani of Bologna are of the first importance.

The simplest form of placental development is found in the diffused placenta of the solipeds.

In the non-gravid uterus of the mare, "the mucous membrane is smooth and velvety, of a rose color inclining to yellowish, and here and there it is doubled over into large and soft folds. In the gravid uterus, on the contrary, the folds are wanting and over the whole surface of the mucous membrane are scattered vermiform projections winding closely against each other, of a very intense deep red color tending to violet, and the surface has a swollen appearance."[1]

Vertical sections of the uterus, in an advanced stage of gestation, show in the place of the mucous membrane, which in the non-pregnant state is scarcely distinguishable, a uniform layer from one to two millimetres thick, which upon superficial examination appears like a transformation of the uterine mucous membrane. Into this the villi of the chorion enter and are somewhat uniformly distributed over the whole uterine surface. "This so-called tumefied mucous membrane has its origin from the sub-epithelial connective tissue and consists of an infinite number of simple glandular follicles, and may very properly, as designated by Ercolani, be considered as a new glandular secretive organ. The villi of the chorion are enclosed by these introflexions and follicular depressions, instead of entering as was earlier supposed the uterine utricular glands. These glandular follicles are supplied with an internal epithelium and are developed only during gestation.

The careful study of the multiple placenta of the Ruminants teaches much of value. Fabricius thought there was a direct communication between the vessels of the mother and the fœtus. Harvey, on the contrary, maintained that the fluid secreted by the cotyledons was absorbed by the villi. This view was sustained by Needham and Haller.

[1] Ercolani, Utricular Glands of the Uterus, etc., page 35.

Digitized by Google

Ercolani has demonstrated that upon the site of the rudimentary cotyledons, which are never wanting in the non-pregnant state, there is developed during pregnancy a new organ of glandular secretory character and that this differs from the diffuse placenta chiefly in being developed over circumscribed areas and in possessing a more complex condition.

The study of the single placenta is beset with far greater difficulties. A transverse section of a gravid uterus of the rabbit at the placental site, the second week of pregnancy, shows three parts each clearly distinct.

1. The muscular wall of the uterus.

2. The placental neoplasm which is developed upon the inner uterine surface.

3. Above this is the old uterine mucous membrane tumefied and about to undergo destructive changes.

Two most noteworthy conditions appear.

The utero-placental vessels have a lumen almost double the vessels from which they proceed, and notwithstanding their greater volume they show in their walls none of the anatomical characteristics, which serve to distinguish the arteries from the veins and which are clearly visible in the uterine vessels.

The second and even more important fact is that these vessels, instead of the ordinary walls, are surrounded with a uniform envelope of cells of a special character, which cannot be distinguished from the cells of the decidua serotina and the maternal placental tissue. The special characteristic of the walls of the vessels, composed as they are seen to be of only the endothelium, is an objection to the supposition that their development could proceed from the vascular network of the old transformed mucous membrane. This is emphasized by the exceptional fact that the old uterine mucous membrane is detached from the muscular wall, and with its glands is undergoing a process of rapid destruction. These facts place it beyond all doubt that the utero-placental vessels and their surrounding cells are the result of a real neo-formative process.

In all animals having a single placenta, the decidua vera and the decidua reflexa are of new and distinct formative character. The decidua vera is composed of newly formed cells which are early arrested in their development and superimposed upon it is

Digitized by Google

the old uterine mucous membrane, usually easily distinguished by its glands, and which later is seen in process of destruction and interblending between the external layer of the ovum and the internal uterine wall.

In most animals the newly formed placental vessels have a uniform diameter and constitute a network of small meshes which reaches as far as and is firmly joined to the chorion.

In the meshes of this network, are found the fœtal vessels which unite and enter the cord. By injection of these we have a better demonstration of the relations established between the fœtal and maternal portion of the placenta.

A careful study affords convincing proof that the umbilical arteries ramify and terminate in a thin fine network of capillaries in the chorial villi and are in close contact with the cellular covering which clothes the maternal vessels. Demonstrative evidence of this relationship in the human placenta has been frequently observed by myself, where the placenta has been undisturbed in its connections with the uterus for a considerable period after the death of the fœtus.

The chorial villi become shrunken and easily separate from the decidual sheath, the cells of which remain unchanged.

In certain of the lower animals (*e. g.*, the *Cavia cobaya* or guinea pig) Ercolani has observed that the maternal vessels become dilated in their terminal loops. This is of especial importance since it furnishes an example in rudimentary condition, of that which takes place in an extreme degree in the human placenta.

The destructive changes in the uterine mucous membrane of woman after conception are limited to the epithelial layer. After the separation of the decidua vera from the internal uterine surface, it is observed that the muscular wall is covered with a mucous membrane identical with that lining the uterine cavity before impregnation. The uterine mucous membrane is little more than a simple layer of epithelium and the reproduction of this is all that is required to restore the internal surface of the uterus to its primary state. During the early period of development of the human placenta, the decidual cells form a richly vascular compact layer surrounding the chorial villi. For a limited time the relationship between the parts is not so intimate that they

Digitized by Google

cannot be separated. At this stage, before the maternal vessels become ectasic, the form of development is not unlike the diffused or disseminated placenta.

The walls of the proliferating branches of the villi are necessarily forced against the decidual layer of cell covering the ectasic, thin walled maternal vessel. Thus this is introflected and a close union ensues. In this manner the so-called placental lacunæ are formed in the fully developed placenta, and, from this very deceptive appearance, it has been held as a demonstrated fact, that the fœtal villi swim in the maternal blood.

The epithelial covering of the vascular loop of the fœtal villus is wanting because of the intimate relation which has been established between it and the secretory villus, which *never* loses its own epithelium. The form of the vascular loop of the maternal villus varies greatly. In the quadrumania and in woman the dilatations become lacunose and are actually enormous.

All the vertebrates during the period of embryonic life, in order to complete the marvellous phases of their development, require a special nourishment which is always furnished them by the mother. This is conveyed to and converted into its own substance by the embryo, and however many and considerable may be the differences met with, in these two fundamental factors, the unity running through them readily appears under two general forms, represented by the yolk of the egg in oviparous animals and by the placenta in mammals. In the first, the maternal aliment is stored up in a mass by the mother and emitted with the ovum in the quantity needed by the embryo to complete its development.

In the second, the nutritive material is furnished by the mother from the placenta which elaborates it as needful for the developing embryo. These materials in every case are absorbed and conveyed to the fœtus by means of its own vascular appendages. Thus nutrition is carried on during the development period in all vertebrates by a single law of physiological modality.

The typical anatomical form in the two fundamental parts of the placenta, however wide the variation, is always identical:—a villus of new formation maternal as well as fœtal, each composed of an internal vascular loop, surrounded by a cellular layer and covered with an outer epithelium. The office only of the villi is different, the fœtal *absorptive*, the maternal *secretive*. These villi always come in contact more or less intimate, but the walls of

Digitized by Google

the vascular loops never in any instance touch. This is the more to be emphasized since it invalidates the idea hitherto held, and yet almost universally taught, that the mode of the nutrition of the fœtus is an interchange between the two bloods by endosmosis and exosmosis. The different ways of the interblending of the fœtal and maternal villi give the complex and confusing picture of placental formation. The belief that the lacunæ were really large cavities as they certainly appeared, and not the maternal vessels greatly dilated, was held as a truth proved and indisputable, and it was through this belief that two other deceptive appearances were received as actual truths, namely, that the villi floated in the maternal blood and that the epithelium covering them appertained to the fœtus instead of the mother.

THE MORPHOLOGY OF ARTERIES. By FRANK BAKER, of Washington, D. C.

[ABSTRACT.]

THE arterial system is remarkable for irregularity and variability; yet an attempt should be made to bring it under morphological laws.

Ontogenetic development shows that the embryo has at first no vessels. These arise by vacuolation of cells which unite to form capillary tubes commencing at the periphery of the area vasculosa and approaching the heart. Uniting, these form trunks along lines of axial growth. This *centripetal* development is to be considered when attempting to interpret the laws which govern the arterial system.

Phylogenetic development confirms and supplements this evidence. The lowest animals possess no proper vessels, but obtain food by protoplasmic imbibition. The alimentary canal may ramify in the sarcode, curiously resembling a vascular system, but analogous only. The water-vascular system formed by a split between the two layers of the body wall is possibly the origin of the lymphatics. The blood-vascular system commences by longitudinal trunks. The movements of the body being more frequent in the direction of the mouth tend to develop such trunks. In

Digitized by Google

higher forms these are supplemented by transverse trunks corresponding to the somatomes. In animals having limbs the limb-trunks show a law of uniform dichotomous division relating to the segments of the limb. If we admit Gegenbaur's theory that limbs arise as buds upon which other buds form in a radiate manner, the arterial ramification can be explained. Some of the arterial trunks belong to aborted rays. When arteries do not divide at the normal point they have a tendency to do so at the node next nearest the heart. This is caused by variability of convergence. One artery may take the place of another by inter-substitution. Functional activity may greatly modify the vascular system. In the intestinal canal (splanchno-pleure) protected from external influences, the cell-life is simple and there has been less differentiation than at the periphery (somato-pleure). The primitive type is more nearly preserved there, and the vessels resemble a capillary plexus vastly enlarged.

The phenomena of ramification can be explained by reference to an ancestral archetype from which the arterial systems of all vertebrates are derived.

The paper was profusely illustrated by drawings and diagrams.

ILLUSIONS OF MOTION. By H. P. BOWDITCH and G. STANLEY HALL, of Boston, Mass.

[ABSTRACT.]

I. IT is a very old observation that when the eye has rested for a time upon a moving object or a series of moving objects and is then transferred to a stationary object the latter seems for a few moments to be animated by a movement in the opposite direction.

Examples of this phenomenon are furnished by watching a waterfall and then looking at the stationary bank, or by looking at the floor of a moving railway car after watching the apparent motion of the landscape without.

The term "subjective complementary motion" has been applied to illusions of this sort on account of the analogy which they present to complementary after images. Prof. S. P. Thompson who

Digitized by Google

suggests the use of this term formulates the following law: "The retina ceases to perceive as motion a steady succession of images that pass over a particular region for a sufficient time to induce fatigue, and on a portion of the retina so affected the image of a body not in motion appears by contrast to be moving in a complementary direction." (See Quarterly Journal of Science, March, 1879.)

The observation of a revolving disk on which a spiral line is drawn affords perhaps the readiest means of studying this illusion, at the same time that it shows the inadequacy of the explanations which have been hitherto offered. If the disk be revolved in such a way as to produce a contraction of the spiral line towards the centre, an apparent expansion is observed when the gaze is directed to a stationary object. Now, if the stationary object thus viewed be a sheet of paper on which a straight line is distinctly ruled, and the eye be directed to a point near but not upon this line, the surface of the paper appears to be animated with a movement of expansion from the point looked at, while the line does not appear to alter its straight direction. In other words, the field of vision as a whole appears to expand, while the separate points in it do not alter their relative position in regard to each other. This is best explained on the supposition that the apparent expansion is a phenomenon connected with the visual centres in the brain, and not with the optical or mechanical apparatus of the eye.

II. The apparent rotation of a set of concentric circles when a "rinsing" movement is imparted to them, as described by Thompson, may be partly accounted for as follows. When a set of concentric circles is moved to and fro across the field of vision, that portion of the circles in which the direction is the same as that of the motion will be mostly distinctly visible. The blurred figure of the circles will thus be divided by two narrow sectors in which the lines will be distinctly seen. Now, when a "rinsing" movement is given to the circles, the direction of the movement is continually changing, and consequently the narrow sectors in which the lines are distinctly seen will appear to move around the circles and thus cause the appearance of rotation. Another factor in the production of this phenomenon is the apparent rotation round a point in its circumference which is produced whenever a circle is carried with a rinsing movement through a circle equal to itself.

Digitized by Google

III. The apparent slow rotation of a circle with internal cogs in the direction opposite to that of the "rinsing" movement, a phenomenon also described by Thompson, appears to be due to the fact that the end of the cog is most distinctly seen when it is in that portion of its course which is most distant from the line from which it arises, for here it is least obscured by after-images of the line. The phenomenon can be equally well observed when two horizontal lines with cogs directed towards each other are subjected to a rinsing movement, the two lines of cogs appearing to move in opposite directions. These experiments will be reported in full in an article which will shortly appear in the Journal of Physiology. (See Journal of Phys. III, 297.)

Demonstration of a Series of Brains prepared by Giacomini's Method. By William Osler, of Montreal, Canada.

[ABSTRACT.]

The brain (human), as fresh as possible, is placed in saturated zinc chloride solution, in which it floats, so that it has to be turned or covered with cotton wool soaked in the fluid. On the second day the membranes are removed. This is the only tedious part of the process, as the dissection must be carefully made about the nerves. After having been in the solution for about a week, the brain is transferred to alcohol (methyated spirits) in which it sinks so that cotton wool must be placed beneath to obviate the effects of pressure. The organ can remain in spirit an indefinite time, but after six or seven days is ready for the third stage of the process,—immersion in glycerine (best), in which it floats. It remains in this until it sinks to the level of the fluid which usually takes a week. It is then removed, the surplus glycerine washed off and the organ exposed to the air in a protected place. When dry it receives a coating of ordinary varnish and remains unchanged for years. The method is applicable to the brains of small animals, and the stages of the process are shorter.

Digitized by Google

Cross Heredity from Sex to Sex. By Mrs. A. B. Blackwell, of Somerville, N. J.

[ABSTRACT.]

There is much evidence that each organic cell and organism assimilates food, builds structure, and performs functions under the same law of equal action and reaction that rules inorganic nature and maintains the balance of work among correlated energies. Thus, each higher organism is differentiated to perpetuate, not another organism like itself, but incomplete elements, the incident forces, which, coöperating with complementary elements, can establish the new organism. Hence a permanent moving equilibrium of male and female influence in the new being; and, by the law of averages, each determines the sex in about equal numerical proportions. There is also a well known family resemblance among brothers and sisters which underlies even unlike physical details and various mental ability, and is often an obvious balance of the dissimilar characters of the parents. Mixed races are the conspicuous blending of both types of progenitors.

But, since special characters are entailed to the same sex exclusively, then a corresponding inheritance of more general characters should be entailed to the opposite sex distinctively, if the balance is maintained.

Several classes of facts were given by the writer in evidence of cross inheritance.

With feeble mothers and strong fathers, daughters, at birth, have an apparent advantage over their brothers; but if the inequality is reversed in the parents, the sons begin life better endowed than their sisters.

If parents are strongly marked contrasts, the sons most often resemble the mother and the daughters the father. When this is not readily evident, intimate acquaintance will often bring out cross inheritance in some other form of compensation.

Idiosyncrasies and traits independent of sex are most often reproduced by cross heredity.

In mixed races, Indian and negro, white blood is presumably a male inheritance, and the women as a class are certainly lighter and more Caucasian in features than the men. But in special cases, where the mother is white, the male children more often

Digitized by Google

resemble the whites. The same law holds in all mixed nationalities to a noticeable extent.

There are complications arising from the general blending of many characters, and therefore room for difference of conclusion; yet, if attention can be definitely called to the facts, it is believed that the compensative law of cross inheritance, from sex to sex, may be definitely established.

THE ORGANIC COMPOUNDS IN THEIR RELATIONS TO LIFE. By LESTER F. WARD, of Washington, D. C.[1]

[ABSTRACT.]

ORGANIC compounds may be defined as "substances whose highly complex and very unstable molecules are composed of those of inorganic compounds or of organic compounds of lower organization, formed on the cooled surfaces of fully developed plants at life-supporting temperatures."

So far as the cosmical origin of the various substances composing the earth's crust, whether elemental or compound, is understood, it seems to have conformed to the following law: the molecules constituting each progressively more complex unit exhibit *increase of mass* accompanied by *decrease of stability*.

The artificial synthesis of organic compounds has obliterated the line formerly supposed to exist between the chemical constitution of inorganic and of organic compounds.

The properties of substances depend upon their molecular constitution: the more complex their constitution the more active their properties. Thus the properties of compounds are as a rule more active than those of elements, those of organic are more active than those of inorganic compounds, those of the alkaloids more active than those of the amyloids, and those of the albuminoids more active than those of the alkaloids. In the last case, however, the activity manifests itself in a different manner, viz., through rapid changes of internal structure including the phe-

[1] This paper was published in full in the American Naturalist, Vol. xvi (December, 1882) pp. 968-979.

Digitized by Google

nomena of isomerism; thus partially ceasing to be molecular and in a certain way affecting the mass.

These nitrogenous compounds themselves possess grades of complexity and instability, and thus we arrive in an ascending series at proteine and finally at protoplasm.

Protoplasm is a chemical substance whose relatively large molecules may have been compounded of those of the less complex albuminoids.

The activities manifested by protoplasm consist in actual alterations in the mass of the substance, which is the fundamental fact involved in the phenomena of life. Life is therefore essentially a property of protoplasm.

All the higher manifestations of life are reducible to protoplasmic activity, and the enlarged scale on which they operate is due to subsequent *organization*. A living being is only a quantity of organized protoplasm, and tissues are merely the framework and material machinery by means of which the life-substance is enabled to multiply effects.

CLASSIFICATION OF ORGANISMS. By LESTER F. WARD, of Washington, D. C.[1]

[ABSTRACT.]

THE terms *animal* and *vegetable* have proved wholly inadequate to express the distinctions which are found to exist among organisms. As popular terms they are useful, but as scientific terms they have already led to much fruitless discussion.

The fundamental distinction in biology should be drawn between those organisms which are capable of assimilating chemical or inorganic matter, and those which depend entirely upon the appropriation of matter already so manufactured. We would thus have two classes of organisms, viz., first, assimilators, tissue manufacturers, or *autogens;* and second, *parasites.*

The first of these classes might be subdivided into three groups: 1. Those that manufacture protoplasm only and con-

[1] This paper was condensed from the writer's work "Dynamic Sociology" (New York, D. Appleton & Co., 1883, Vol. i, pp. 347-355), published since the Montreal Meeting.

Digitized by Google

sist entirely of that substance. 2. Those that manufacture both protoplasm and also some form of protective integument or framework. 3. Those which decompose carbonic dioxide and employ the carbon thus liberated as the strengthening material of their tissues, viz., plants proper.

The second class is also divisible into three groups: 1. Those which appropriate matters already manufactured by organisms of the first class (or, as in the case of lichens, take them at third hand from organisms of the same class), but which are not only fixed like plants but are of low organization and simple cellular structure. 2. True parasitic plants, whose organization plainly indicates that they have descended from chlorophyl-bearing plants, of which they are degraded types. 3. Animals proper, which live on the substance manufactured by the first class of organisms, either by taking it directly from plants, or by preying on others of their own group which have derived their sustenance from plants.

TITLES OF OTHER PAPERS READ IN SECTION F.

NOTE ON THE OCCURRENCE OF TRACES OF A NORTHERN FLORA IN SOUTHWESTERN OHIO. By E. W. Claypole of Yellow Springs, Ohio.

NOTE ON THE STERILITY OF THE CANADA THISTLE AT YELLOW SPRINGS, OHIO. By E. W. Claypole of Yellow Springs, Ohio.

INSECTS VERSUS FLOWERS IN THE MATTER OF FERTILIZATION. By E. W. Claypole of Yellow Springs, Ohio.

A SKETCH OF THE HISTORY OF OUR KNOWLEDGE OF THE BUDDING OF SALPA. By W. K. Brooks of Baltimore, Md.

FRITZ MÜLLER AND THE NAUPLIUS OF DECAPODS. By W. K. Brooks of Baltimore, Md.

Digitized by Google

DESCRIPTION OF A NEW GENUS AND SPECIES OF ALCYONOID POLYPS FROM JAPANESE WATERS, WITH REMARKS ON THE HABITS AND STRUCTURE OF RELATED FORMS. By Robert E. C. Stearns of San Francisco, Cal.

ON THE POLYMORPHISM OF LYCAENA PSEUDARGIOLUS. By W. H. Edwards of Coalburg, W. Va.

ACHAENODON FROM THE BRIDGER EOCENE BEDS. By Henry F. Osborn of Garrison-on-Hudson, N. Y.

AN EXAMINATION OF SOME CONTROVERTED POINTS OF THE PHYSIOLOGY OF VOICE; ESPECIALLY THE REGISTERS OF THE SINGING VOICE AND THE FALSETTO. By T. Wesley Mills of Montreal, Canada.

BLASTESIS TRIDENS; A PEAR TREE FUNGUS. By William H. Seaman of Washington, D. C.

PROGRESSIVE GROWTH OF THE DERMOID COAT OF THE MEMBRANA TYMPANI. By Clarence J. Blake of Boston, Mass.

REMARKS ON THE TURBELLARIA. By Wyllis A. Silliman of Clarkson, N. Y.

NOTES ON THE FLORA OF THE ROCKY MOUNTAINS OF IDAHO AND MONTANA. By Sereno Watson of Cambridge, Mass.

ON THE VENOMOUS PROPERTIES OF THE TOAD. By J. A. Crevier of Montreal, Canada.

NOTES ON SPIDERS. By Henry C. McCook of Philadelphia.

Digitized by Google

SECTION G.

HISTOLOGY AND MICROSCOPY.

Digitized by Google

Digitized by Google

ADDRESS

BY

PROFESSOR ALBERT H. TUTTLE,

VICE PRESIDENT, SECTION G.

FELLOW-MEMBERS OF THE SECTION OF HISTOLOGY AND MICROSCOPY:—

IT is my esteemed and honorable privilege to preside over the first session of this body held with its present organization and standing as an independent Section of the Association.

In assuming the duties and the honors conferred upon me, I find my mind reverting to the antecedents of this Section and the days of its beginnings. Some, at least, among you will recall with me the daily gathering of a little company in an out-of-the-way room during the Salem meeting of the American Association in 1869, to which the name of "the Subsection of Microscopy" was first given.

Long shall I remember the sessions of that meeting, half formal, half informal. There we debated (or listened while others debated) gravely whether or no the "nineteenth band" had really been resolved. We triumphed unitedly in the clearness of the demonstration by one of the more expert of our number of the "basket-work" upon *Surirella gemma*,—*ultima thule*, then, to us of test-objects; and some of us, at least, looked for the first time, at and through what was for us the crowning wonder of the day—a Wenham binocular! We discussed there in simple faith the merits and demerits of "that quality in an objective termed penetration," without a shadow of doubt as to whether we agreed as

Digitized by Google

to what we meant by the expression, or any dream of the latter-day skepticism as to the very existence of the "quality" we so earnestly discussed. We listened eagerly while the late Mr. Bicknell described the method by which he made his then unrivalled injections, the open secret of which appeared to be, when all was told, that the way to make good injections (or good anything else) was to take each step intelligently, carefully and correctly; and we gazed with interest, if not with admiration, at a demonstration, which some who were present then will perhaps recall, of how a microscope can be made to serve as almost anything that it was not intended to be, if you only modify it sufficiently, and add pieces enough.

This sounds like childish talk, but such was the infancy of the body that sits here to-day; and this, let me add, was in what might almost be called the childhood of microscopy in America. True, there were already in this country many excellent microscopes (including a due proportion of the wonderful binoculars) and a goodly number of excellent microscopists, not a few of whom had risen far beyond the level indicated by the scenes that I have described. True, much excellent research, some of which stands to-day as no less excellent, had been carried on in America long before the times of which I speak, by solitary workers, scattered here and there over the eastern states, the names of many of whom will be recalled by each of you as I speak; but that general interest in the microscope and its revelations which forms so large a part of the intellectual activity of to-day was as yet hardly known, and among those devoted to scientific and even to biological research the microscope was far too often an infrequent and unimportant auxiliary.

If microscopes were not as numerous then as now, neither were they as easily to be had. In that day he who wanted to buy a microscope had to hunt for it. To-day I had almost said that a man must be rather ingenious to avoid buying half a dozen. Then, he who wished an instrument from a foreign workshop had to make it the subject of a special order; to-day half a dozen importers carry extensive stocks of the instruments most likely to be in demand. Then, as regards American-made microscopes, if a stand was wanted, the buyer looked (and not unwisely) first of all, to a little shop in Philadelphia where labored and still labors—long may he do so—one, the thoroughness and fidelity of whose handi-

Digitized by Google

work alone enable him still to hold his own against a score of competitors, who by hand and by steam are putting yearly upon the market countless instruments of every conceivable plan and of all grades of excellence. If one sought for objectives of the highest character he must perforce seek the atelier in Boston of one who then stood without a rival on the American continent. Though his work is, as I believe, yet to be surpassed, one may look to-day not unprofitably in three or four other directions to find makers of thoroughly excellent objectives; objectives, if you choose, whose available angle of aperture includes, as a still skeptical friend of mine dryly puts it, by far the greater portion of a circumference: while as regards low powers and moderate angles, the market now abounds with excellent American-made objectives.

I would not overlook the fact that there were other makers in this country at that time; men who made excellent stands, and men who made excellent objectives; but I am confident that I do no injustice to others in saying that the two whom I have indicated were the only ones at all widely known.

The increase I have indicated in the number of prominent makers, is, of course, directly associated with an increase alike in demand and in production; but who can realize the magnitude of that increase? The makers of that day counted their results by dozens; the yearly aggregate production of to-day must be told by thousands; and it can then hardly keep pace with the demand, in spite of the large additional importation of English, French and German instruments. Competition has, as usual, been followed by the two substantial benefits of improvement in quality and reduction in price. I think sometimes almost with regret of my first venture, recalling how little I then obtained for my scant eighty dollars, and seeing how much that is really excellent, both mechanically and optically, can be commanded by the beginner of to-day for the same or even a smaller sum. At that time, too, books, appliances of every sort, and, most valuable of all, personal hints and suggestions from those of experience, were scarce and hard to be obtained. To-day few communities are so small or so remote as not to furnish all three in varying quality.

Such, as I recall them, were the impressions made upon a young western teacher, himself then a beginner (and even now but little more), of the times and the sessions of the first Sub-

Digitized by Google

section of Microscopy of the American Association. The effort made at that time to bring together the workers with our favorite instrument was renewed from year to year at succeeding meetings, the movement gathering strength at Troy, at Indianapolis, at Dubuque, at Hartford, at Detroit, at Buffalo (where the Subsection acquired the dignity of a permanent organization), and at each succeeding meeting, until the result has been obtained which we witness to-day.

While the vastly increased interest manifested in America to-day in the microscope and its use must, of course, be chiefly attributed to that phenomenal movement in biological science which we have been so happy as to witness, and from which we have derived so many and so varied benefits, I think I may justly claim that no small credit should be given to the yearly meetings of the Subsection, with their usual exhibitions and soirees, giving to the people of the various communities in which we have met notice at least of the existence of such a thing as a microscope, with some scant glimpses of the wonders that it has to show; awakening here and there an interest that has ended in something more than mere curiosity-seeking and amusement; drawing together and uniting those of a common interest: to which last effect may, I think, be at least indirectly traced a result whose future offers great promise of good, the organization of the young and vigorous American Society of Microscopists; an organization in whose power it is to do a great amount of excellent work that could be done by no other means as well. The influence exerted in one way or another by our half score of sessions would, I think, if it could all be measured, far exceed in value the papers that have been read at them, though these have been neither few nor unimportant.

Such has been our prentice-work; we stand henceforth among our equals as a Section. It would be pleasant here to pass from recollection to prediction, and to spend the remainder of the half-hour in the discussion of great possibilities; we shall do otherwise, however, if we give heed to the pithy suggestion contained in an ancient but excellent volume of practical philosophy (with which I trust that most of you are familiar) concerning boasting and the putting on of armor.

And this the more wisely because another topic of a far different nature presents itself, and, I may almost say, demands attention.

Digitized by Google

Before telling what we intend to do, we are in a certain way called upon to defend our right to be. It is commonly known, I think, that not only in the Standing Committee of last year, but also throughout the membership of the Association, there have been felt and expressed grave doubts not only of the necessity but also of the propriety of raising the Permanent Subsection of Microscopy to any higher dignity: while the extension and associated limitation of its province which the new name of the Section connotes, though they have so far satisfied these objections as to lead to its establishment, have called forth from others even stronger criticism, as raising to the rank of a distinct department of science that which they had hitherto regarded as holding a far subordinate position. Respect for the candor and the ability of our critics, as well as for their zeal for the wise ordering of the affairs of the Association, would of itself demand that these objections be met and answered. I shall deal with them to the best of my ability; should my arguments fail to carry conviction, I trust that the weakness will be attributed to the advocate rather than to the cause.

To the question first referred to, it has been considered a sufficient answer to urge the fact, which will, I think, be universally conceded, that there is no other instrument of research known to scientific men that has attained so high a degree of development as the microscope; no other whose parts both mechanical and optical have been the subject of so much prolonged, earnest, and fruitful discussion; none which has so many and so varied accessory appliances pertaining to it, in relation with its almost endless diversity of uses. Furthermore, this high degree of development calls for a proportional degree of training in the worker. There is a great amount of study of the instrument itself demanded of him, side by side with an equally great amount of labor that may be regarded as gymnastic in its nature (in which we see the final cause of diatoms for all but cryptogamic botanists, and of ruled plates for all mankind); while the various processes by means of which objects of study themselves are brought into a suitable condition for examination and preservation call for no little skill and practice. It is urged, therefore, in view of the peculiar character and wide applicability of the instrument in question, and of the extent and arduousness of the discipline that its skillful use requires, that they who have in greater or less measure acquired this

Digitized by Google

discipline are by virtue of that fact drawn together, forming a body of sufficient coherency to be entitled to independent standing as a Section of this Association.

I have endeavored to state the argument in favor of a Section of Microscopy briefly but fairly. Love of justice makes me anxious not to understate it, for, as many of you are well aware, I am one of those who have questioned strongly the propriety and wisdom of organizing such a Section; and I must confess that after an honest endeavor to put the case as strongly as possible in my own mind for those who think otherwise, and to convince myself of the truth, whatever it may be, I am still of the same opinion.

For I do not see what more we can say of Microscopy than that it is a technique; so elaborate, so complex, that its acquirement in any considerable measure is in itself a valuable discipline, but a technique still. No one feels more strongly than I its fascination; no one is more alive to the feeling of sympathy that unites the brotherhood of the tube. I have as lively and practical faith in the value of societies of microscopists and in journals of microscopy, as I have in other technical societies and periodicals. I believe, as I have already said, that they can under certain circumstances do a work for science that can be done in no other way as well; but I cannot see the propriety, in an Association whose aim is first, last, and always the advancement of science, of establishing a Section on a purely technical basis.

Nor, were its propriety conceded, would it, in my judgment, be either wise or expedient to do so, considering either the efficiency or the stability of such a body. The almost universal applicability of the microscope is in itself a bar to that unity of purpose which should be the first characteristic of a working organization. I can perhaps illustrate this to advantage by referring to another instrument of research which has attained in its various forms and uses a very high degree of development, and whose use calls for no small amount of training and experience: I refer to the polariscope. Were we to gather into one body all the chemists, physicists, mineralogists, and biologists who make more or less extensive use of this instrument in scientific investigation (to say nothing of the various groups of those who apply it extensively to the affairs of every-day life) we might make a Section of Polariscopists; but it would soon unmake itself.

Digitized by Google

I know that this will be regarded by some as a false analogy; and that appeal will be made to the prevalent idea — far too prevalent in my judgment, since it is largely responsible for that diffusion of energy whose practical exponent is the fact that the number of microscopes sold yearly in this country is in proportion to the number of valuable original contributions on microscopic subjects annually produced as over fifty to one — that the expert microscopist is he who, having a good stand and a number of good objectives which he can handle dexterously, has also a large cabinet of objects, mostly of his own preparation, illustrating as many of the various applications of his instrument as possible; one who, not specially a botanist, is at home with diatoms and algæ; not calling himself a zoölogist, has a certain familiarity with infusoria, entomostraca and rotifera; not claiming to be an histologist, has cut and stained numerous sections of both plants and animals; neither a geologist nor a mineralogist, has ground, polished and mounted many sections of rocks and corals; not a chemist, — but why extend the category? one, in fine, who, in accordance with a tradition whose history would be full of interest had we but time to trace it, has acquired skill enough and expended brains and labor enough in a dozen fields to have made himself a master workman in any one of them. I confess that I cannot but regard this idea as an idol of the tribe: to my mind the skillful microscopist is he whose hand has learned all necessary manipulations, whose eye has been trained to nice and quick distinctions, and whose judgment, resting on accumulated experiences, can interpret rightly the appearances presented to his eye: and he is most successful who having chosen a definite field of labor has worked most diligently therein to increase his own or the world's stock of knowledge.

I would not be unmindful of the fact that there are those who, working with the microscope, have entered many fields, and gleaned, nay, reaped richly in them all; but they are few: neither would I pass unkindly criticism on those who using the microscope avowedly only as a recreation find pleasure and substantial profit in passing from time to time to fresh fields and pastures new; I take it, however, that the Sections of this Association are organized primarily, if not solely, with the view of bringing together most closely those whose labors have most in common; and however it may be with objectives, we may be sure that for Sections of this

Digitized by Google

Association not only penetration but definition also is in inverse ratio to angular aperture.

It was therefore the judgment of the Standing Committee (and this judgment was ratified by the vote of the Association at large) that this Section should be established not purely nor indeed chiefly for that technique which the word Microscopy implies; neither should that name stand as the label for a receptacle for communications having only this in common that the objects of investigation are too minute or of too fine a structure to be examined by the naked eye. They have, instead, established a Section devoted to that department of science whose investigations must be wholly carried on by the aid of the microscope, and to the technique of the instrument as auxiliary to it. As in the Section of Chemistry papers discussing appliances and methods whereby a more accurate analysis or a more complex synthesis may be obtained find place and welcome, or in the Section of Physics discussions of means as well as of results of investigation are gladly received, so here the presentation and description of new apparatus, the discussion of new methods of preparation, of manipulation, or of demonstration find appropriate and ready audience; but I present as my opinion, which I hope will find echo in your judgment, that papers on subjects pertaining to micro-chemistry (if there be such a thing as micro-chemistry) will best be read to chemists: that papers in what are termed micro-geology and micro-petrography will find readiest and most appreciative listeners in the Section of Geology. I would even suggest that a paper on the entomostraca or the rotifera, particularly if it deals with the morphology or the systematic position of the form or group in question, will find its normal auditors among the zoölogists in the Section of Biology.

What then remains to us? I have spoken of that department of science whose investigations must in the nature of things be carried on wholly by the microscope, as being designated by the organic name of the Section as its particular field of labor. I say, that department of science; knowing that the expression must call forth that adverse criticism to which I have alluded and to which I must now address myself. It has been urged that Histology is in substance but a finer Anatomy; a dissection made with the eye where the scalpel cannot go; at best no better than the handmaid

Digitized by Google

of Physiology: and that to dignify it with the rank of a distinct department of science is to give to the servant the honors due to the mistress.

This, I acknowledge, is the traditional view: and this, unfortunately, describes only too well the Histology that is too often studied and too often taught to-day: but I am persuaded that the beginnings have already been made of a newer and a greater Histology than this: the leaven that has leavened the whole lump of biology in the last quarter century is working here as elsewhere; and the resulting recombination of ideas has given us a conception of the significance of the phenomena of cell-life of which a previous generation hardly dreamed.

As a rich and fertile soil whose yearly harvests pay abundant rental for its tillage may long overlay unsuspected mineral wealth of far greater value, so it often happens that a discovery that proves itself at once of great practical importance may remain for a long time with its philosophical significance unrecognized. The results of that enquiry into the structure of the organs of living beings which the immortal discoveries and inventions of Lister and his contemporaries first made possible were found to have so much practical value to the physiologist that they were at once appropriated to his use. This analysis did not at first go beyond an idea of fibres, cells and membranes; it did not seek and only vaguely dreamed of any kinship between them; later, when their essential affinity was at first surmised and then demonstrated, the fact was, save by a few, regarded as of secondary importance to what had now come to be commonly known as Physiological Anatomy.

To-day, however, the situation is changing rapidly. The conception long since advanced by one of the greatest of living thinkers that the continuous processes of adjustment of relation which make up all we know of life are the resultant or algebraic sum of the activities of the structural elements which make up the living being, and that organs and organism alike must be regarded as the consequence of the integration of countless cells or nucleated corpuscles, is yearly gaining wider acceptance. Some one has said that the doctrine of the survival of the fittest is the equator of the sphere of biology: may I express the opinion that the conception to which I have referred will one day be for physiologists at least its prime meridian? However this may be, this conception,

Digitized by Google

it will be readily admitted, has greatly enhanced the significance and the dignity of the study of cell-life.

There is another and even more important relation of Histology to Biology that is very apt to be overlooked by those that regard it as adequately described by the name of Physiological Anatomy. I refer to its relation to morphology, and its bearing on questions of affinity and classification. Were it proposed to establish in this Association a Section for Comparative Anatomy, or for Comparative Embryology, no one, I am sure, would for a moment question the propriety of such action in either case: I think I am warranted in the assertion that Comparative Histology stands today where the former did at the beginning and the latter at the middle of the present century, and in the opinion that the day is not far distant when its indications will be as confidently received and as diligently heeded as those of either of its allies. From a number of illustrations that occur to me I will take time to mention but two. You are all, doubtless, familiar with the homologies that were once regarded as established between the Trematoda and the Cestoda: you are equally well aware of the doubts that have been thrown upon them in later days by the failure to discover associated embryological resemblances: in my judgment these doubts will disappear in the mind of any one who will carefully study the histology of a tape-worm and of a fluke. As a representative of morphological problems requiring to the full as much aid from Histology as from Anatomy or Embryology, I would suggest the great one yet unsolved presented by the nervous axis of vertebrates; I am convinced that we shall wait for a clear and accurate conception of the morphology of the brain, and of the homologies existing between the various parts (our present ignorance of which we have buried beneath a mountain of terminology) of the widely differing brains of mammals, sauropsidians, amphibians, selachians, teliosts and marsipobranchs, until, beginning at the bottom of the series and ascending along diverging lines, we have worked out by histological methods the structure, development, position and connections, both primary and adapted, of every mass of gray matter in that galaxy of puzzles.

The claim of Histology to rank as a distinct department of science might well be allowed to rest upon the amount and the nature of its increased importance, both physiological and morpho-

Digitized by Google

logical, that I have indicated: there is another consideration in its favor, however, that I regard as far weightier. I have hitherto spoken of tissues and their activities as related to the functions and the structure of organs and organisms. I would now call your attention to the value of the study of cell-life considered in itself. We have most of us had our eyes opened for some time to the magnitude and the significance of the struggle for existence that goes on at all times between organisms; it is only recently, however, that our attention has been definitely called to the struggle of parts within the organism, and to the probable truth that every organ is where it is and what it is through a long series of adaptations to its environment. And this analysis must be carried still farther: for as the body is built up of its organs, so, as I have already said, is each organ the result of the integration of its cellular elements. The great law of biology that gives order and system elsewhere leaves no chaos here; and our Histology is not complete until every tissue and every cell has been studied in its light.

Here, then, is our province. Is it not ample enough? It embraces the study of cell-life, in all its bearings, in plant and animal alike. Since sound fundamental ideas of the laws which govern cell-life can only be obtained by prolonged and careful study of those plants and animals which consist but of single cells, or of undifferentiated social aggregates of cells, I claim for hearing here all papers relating to the Protozoa and the Protophyta, including particularly the ferment-organisms on account of their frequent pathogenetic function. Before us come, of course, all papers dealing with cell-life in the higher organisms; papers alike upon the morphology of cells and on higher morphological questions treated by histological method; papers alike on the development of cells and on the structure and significance of embryonic layers and tissues. The newer Histology is still the helpmeet if not the servant of Physiology; while large place will be given here to questions of cellular teratology—for what is Pathological Histology other than this? Lastly, but not leastly, we shall welcome here all papers and discussions calculated to help us either to better microscopes, or to a wiser use of those that we now have.

I have felt, for special reasons, that it was particularly incumbent upon me before presiding over the first session of the Section of Histology and Microscopy, to present to you my interpre-

Digitized by Google

tation of the organization of the Section, and my idea of its future policy. Since this meeting has it in its power to do much to determine the future line of action of the Section, I trust that we shall all agree upon the one here presented or a better. Should your judgment approve of the view that I have taken, I am confident that you will join me in a modest expression of the desire that as in the past the Subsection of Microscopy did much to cultivate a widespread popular interest in the microscope, so in the future the influence of this Section may do much to concentrate and economize the energies of microscopists, and of the hope that as the parent Association represents the aggregate of American scientific research, so our little body may one day come to be the representative of all who labor with us in our chosen field.

Digitized by Google

PAPERS READ.

Plant-"cells" and Living Matter.[1] By Louis Elsberg, of New York, N. Y.

[ABSTRACT.]

This paper, illustrated by carefully prepared drawings, records the discovery of perforations in the cellulose walls of plant-cells giving passage to protoplasmic offshoots from the interior and demonstrates how in a plant, as in an animal, the living matter throughout is uninterruptedly connected.

The third corpuscular element in the blood. By W. Osler, of Montreal, Canada.

[ABSTRACT.]

By the third corpuscular element in the blood I mean certain small colorless discoid bodies $\frac{1}{3}-\frac{1}{5}$ the size of red blood corpuscle, quite common in the blood of mammals and about which much discussion is at present taking place. They circulate free in the blood with the other corpuscles, but in the withdrawn fluid tend to adhere together forming irregular clumps or collections. They correspond to Zimmerman's "elementary corpuscles," to the individual elements of Schultze's granule masses, to the Hæmatoblasts of Hayem and to the "Blutplatchen" of Bizzozero. Scanty in the blood of healthy adults, they abound in the blood of the young and in that of individuals in an anæmic or cachectic condition. The most suitable object for their study is the blood of the young rat, in the vessels of which they can be seen as isolated corpuscles.

[1] Published in the Quarterly Journal of Microscopical Science, London, January, 1883, p. 87.

Digitized by Google

The paper considered, first, the possible connection which these bodies have with the development of the blood; and second, their influence in determining the formation of fibrin.

The Development of Blood Corpuscles in the Bone-marrow. By W. Osler, of Montreal, Canada.

[ABSTRACT.]

A BRIEF resumé was given of the views current regarding the development of blood corpuscles.

The red marrow always contains a form of corpuscle, thought at one time to be peculiar in the mammal to the blood of the embryo, viz., the nucleated red cell. This is an intermediate stage between certain of the colorless marrow cells and the ordinary red corpuscles. The stages as traced by the author are (1) the colorless marrow cell becomes less granular, the protoplasm gets more homogeneous, (2), it becomes gradually tinged with hæmoglobin, the tint becoming progressively deeper until it may attain that of the ordinary corpuscle. The nucleus remains unaffected. In this form they constitute the well known nucleated red corpuscles. (3) The nucleus or nuclei gradually disappear, often first breaking up into smaller portions and the entire protoplasm of the cells is uniform and undifferentiated.

These observations of the mode of production of the red non-nucleated cell in the marrow accord in the main with those of Neumann. The view expressed by some authors (Rindfleisch *et al.*) that the nucleus migrates from the cell is believed to be incorrect. The appearances on which it is based are known to the author, but they are believed to be the result of physical changes.

Note on the Microcytes in the Blood and their Probable Origin. By W. Osler, of Montreal, Canada.

[ABSTRACT.]

MICROCYTES are exceedingly tiny red blood corpuscles $\frac{1}{5000}$ to $\frac{1}{3000}$ of an inch in diameter which are met with (1) in the blood

Digitized by Google

of embryos and of the new-born. (2) Occasionally, and in small numbers, in the blood of healthy individuals. (3) In certain diseases, particularly the severer forms of anæmia and (4) after severe hemorrhages.

No satisfactory explanation has been given of their origin. The author has, in the spleen tissue and in the bone marrow, seen their production by a sort of budding from the ordinary red blood corpuscles. In the conditions above mentioned, particularly after hemorrhages and in profound anæmia the red corpuscles often present great irregularities in outline and projections (Porkilocytosis of Quincke). In fresh specimens of spleen and bone marrow the author has seen these little projections become detached from blood cells — moving about in the currents in the slide — and when so detached they presented all the characters and appearances of the microcytes in the same field.

The Histology of Uterine Fibroid Tumors. Illustrated by a Series of Micro-photographs.

By Henry O. Marcy, of Boston, Mass.

[ABSTRACT.]

The histological elements of the uterine fibroid tumor have usually been considered to consist either in very large share of connective tissue, or of a blending of connective tissue with muscular fibres; *i. e.*, a fibrous or a fibromyomatous growth. The objects of the investigations, of which the micro-photographs are shown in illustration, have been to determine more thoroughly not only the composition of these growths, but also their relations to the surrounding uterine tissue. It is scarcely pertinent to the objects of this meeting to enter into a detailed discussion of the pathological changes which ensue, but the subject is rather introduced to show the advantages of micro-photography and its easy reproduction by the heliotype and other similar processes. Its great value in histological and pathological teaching is undoubted.

The sections were made by the use of Dr. Hailes' freezing microtome and in their preparation and mounting, as well as photo-

Digitized by Google

graphing, I am largely indebted to the valuable assistance of Dr. Alfred F. Holt, of Cambridge.

The photographic work was done in the studio of Mr. Black, of Boston, an expert in this direction well known to America, and in my judgment challenges favorable comparison with even the justly celebrated work of Dr. J. J. Woodward of Washington.

The conclusions reached, as the results of these observations, are briefly: that the origin of these growths is not in reproduction of connective tissue cells, having as a point of departure a vessel or a nerve, but that it consists of an extraordinary development of true muscular fibres of the uterus, usually arising from several centres, resulting in a multi-lobular growth, and may consist of one or more independent tumors.

In their development, these fibres are more or less altered in character by compression, and when of considerable size, by lack of nutrition. The connective tissue stroma is not usually increased, but is often less than that of normal uterine tissue. The tumors are rarely supplied with vessels of any considerable size but depend for their nutrition in large share upon the blood supply of the network of surrounding vessels which is usually exceptionally developed and the vessels are often ectasic in character.

The capsule is composed of the muscular fibres of the surrounding uterine wall, its cells greatly altered by continuous tension and compression, and is not in any degree a proliferation of connective tissue.

Around the tumor there are usually several of these capsular layers which may be peeled or stripped off. They are so changed in their character that it is not remarkable they have been considered as made up from connective tissue.

On the contrary the tumor attachment to these layers, and to the more dense uterine structure, is very slight and is composed of delicate bands of connective tissue. The histogenesis of the myomatous tumor and especially of its relations to the unchanged surrounding uterine structures, in its surgical bearing, is of the first importance.

Digitized by Google

Some Vegetable Poisons. By J. T. Burrill, of Champaign, Ill.

[ABSTRACT.]

During several years I have occasionally noticed within the closed cells of apparently healthy plants of divers kinds, numerous actively moving particles which in form and motion were indistinguishable from some kinds of lower organisms we call bacteria.

Knowing that such cells have for their exterior a cellulose membrane in which there are absolutely no imperforations large enough to be discovered by the best and highest powers of our modern microscopes, the idea of living organisms gaining entrance to the cell and dwelling imprisoned there was further stifled under a presumed impossibility. This also must have been the case with many other botanists and microscopists, for the phenomenon is by no means rare, yet unrecorded so far as I know.

But the evidence is too strong to admit of further doubt that bacteria of several kinds do inhabit the cells of apparently healthy plants.

Some of the best instances observed by myself have been in the cells of certain mould fungi and especially in the fertile threads of *Ascophora mucedo*, a common black mould on damp bread, decaying fruits, etc. In the higher plants the most satisfactory cases have been in the cells of hairs through whose transparent walls everything within can be easily seen; but sections of tissues frequently give evidence of the same thing in the deeper layers.

These things, however, did not attract any considerable attention until it became manifest to me through a series of investigations, that bacteria cause *disease* in plants, especially such as we call "blight" in the pear tree, apple tree, etc. The older observations were then recalled, and upon further study, satisfactory evidence of the existence in plant cells of veritable living organisms, capable of propagation outside of the tissues was gained.

Surprising as these results are, they may not be more so than the known fact that bacteria occur in and on the bodies of healthy animals. In human beings they are found in the scurfy skin of the scalp, in the perspiration from the face, and especially in the epidermal exudations from portions of the body covered with clothing, in the mouth, the stomach and the intestinal tube, and

Digitized by Google

sometimes in the blood. Some of these may perform important physiological functions and therefore may be essential to our well-being, while it is positively known that some specific kinds are our mortal enemies, constituting the active principle of pestilence and contagion.

Another circumstance called still further attention to the living organisms in plants. A lady was severely poisoned with *Rhus toxicodendron*. The exuding serum from the inflamed part, and the leucocytes from the miliary vesicles, were found to contain swarms of bacteria of the genus *Miccococci* as defined by Cohn. It was demonstrated that these organisms transferred from the inflamed to healthy parts of the body communicated the severe malady, that they rapidly increased in numbers and were a true *contagium vivum*.

Search was now made and similar organisms found in washings of fresh leaves and in the juices of the poisonous plant. To rigidly test the matter, a little of the milk sap was secured free from anything not contained in itself and diluted with distilled water to such an extent that the fluid had a slight milky appearance, yet was nearly transparent. A minute drop of this was placed on my own arm after marking the spot by clipping the hairs thereon. The strongest chemical caustic known would not thus cause any serious lesion of the skin, diluted as it was a hundred fold. No sensation was produced at the time, neither was there any marked indication of effect during ten hours following. But on awaking the next morning, eighteen hours after the application, the spot was evident from its redness, and there was a slight sensation of heat in the part. These symptoms rapidly increased, becoming strongly marked by the twenty-fourth hour, and at the forty-eighth my arm was much inflamed and considerably swollen. There was intense itching; the inflamed area increased until by the sixth day my whole arm was involved. After about ten days the malady had evidently run its course and gradually abated. The microscope showed the characteristic bacteria; these were again proved to transmit the trouble to a healthy part of the skin and there increase as before. Indeed nearly my whole body became more or less affected and the difficulty became chronic in certain places, lasting for months though less severe than the original inflammation.

There is positive proof that individuals are sometimes poisoned

Digitized by Google

by simply approaching, without touching, this plant as well as some of its congeners. Here again, the only explanation is that the minute quantity of the poison received is capable of increase by growth. Having seen by the aid of the microscope a something from the plant, and also in the inflamed tissues, which does thus increase and which being placed on a healthy part reproduces itself and the disease, we conclude this something is the *vera causa* of the infection.

When the living organisms have gained access to the deeper layers of the skin, it is difficult to reach them by medicinal applications; but in other cases, any antiseptic substance tried proved quite efficacious. If a little diluted carbolic acid is applied to the skin soon after the poisonous juice has been experimented with, no evil consequences follow. Quinine seems to be an excellent remedy.

The organism is spherical, usually single, but often seen in twos, seldom in strings of four or more, about $\frac{1}{2}$ μ (.00002 inch) in diameter.

The above, though the best and clearest, case of plant poisons being due to bacteria is not the only one. There can scarcely be a doubt but that the ill effects of numerous species of different orders and classes are produced in the same way. I will mention only the poisonous fungi sometimes unwittingly used for food.

There are two pretty well marked modes of mischievous action from the use of such plants, operating either singly or combined. In one case the bad results are soon made known by pain and vomiting, in the other the unfortunate victim perceives nothing wrong for six, ten or more hours after eating the poisonous food. The first has been ascribed to a peculiar acrid, the second to a narcotic principle in the mushrooms. The former, though violent, is not nearly so dangerous as the slower action of the second. When both act together, or rather one follows the other, peril is imminent.

The first symptoms of the latter kind are usually a heaviness of the head, a confusion of ideas, an inclination to stupor; these are succeeded by sickness at the stomach, vomiting and purging and a burning thirst. Convulsions follow, cold perspiration appears and death occurs either in the agonies of pain or in a profound and hopeless stupor.

Digitized by Google

Four persons died in this way in Brazil, Indiana, in October, 1881, from fungi cooked and eaten at noontime, Oct. 16th. Two died in the afternoon of the eighteenth and two on the twenty-second. The last, a strong man, was able to walk about the room until a few hours before his death. Towards the last there was no particular pain; but decomposition evidently set in before death.

I relate these terrible accounts to show what effects may follow the use of such poisonous plants for food, yet I have myself eaten in quantity, and have known many others to eat, of the very same species which caused these deaths in Indiana. The plant is a very large parasol-like fungus sometimes found in great abundance in pastures and meadows (*Lepiota Morganii* Peck). In the making of catsup it is well known that all sorts of mushrooms are collected and used for the purpose without ill effects. I was once asked to taste of some supposed mushrooms which had been put into strong vinegar some weeks before and which, thus pickled, had been eaten with nothing but pleasant remembrances of the fine flavor; yet these were certainly poisonous species. The vinegar had also been swallowed without injury, showing that the poison was not simply extracted; was it not killed? Is not the immunity mentioned above explained better by the cooking than by anything else? The fungus just named belongs to a very suspicious group and it was only by careful experiment that I came to eat it and then only after thorough cooking. To this it is usual to answer that the poison is volatile and is driven off by heat; but why so tardy in its action followed at length by such fearful results? That living micro-organisms exist in such fungi is certain; do they not in some instances cause the mischievous results? The bad effects occurring soon after swallowing the material is quite surely due to a poisonous substance and it is still doubtful what effect cooking may have upon this; but the consequences are never so severe as with the slower acting so-called narcotic effect.

Upon a careful perusal of the exaggerated injuries ascribed to the famous Upas tree there does not seem to me any other theoretical interpretation of the facts so suggestive as this of the action of living organisms tenanting its tissues.

Digitized by Google

Notes on some of the Structural and Physiological Peculiarities Incident to the Diseases of Fruits. By D. P. Penhallow, of Mountainville, N. Y.

The facts contained in the following notes have been obtained as the joint results of investigations conducted on the one hand by Dr. C. A. Goessman, of Amherst, Mass., who has examined the subject from a strictly chemical standpoint; on the other hand by myself, using the microscope and viewing the question from a botanical standpoint. My object in presenting these notes to the Association is not to bring forward any well established conclusions, but rather to offer a report of progress upon work which demands much time and critical examination before it will be safe to present anything more definite.

Our work has been largely confined to studying the peculiarities of peach trees affected with the yellows, and the following remarks will bear directly upon that subject alone.

In his studies upon this subject, Dr. Goessmann has shown from ash analyses, the relative importance of certain mineral constituents in the vegetable economy and the relation which they bear to a healthy and diseased condition[1]. The following analyses, calculated upon a basis of 100 for the five constituents given, will show the importance of the relations first referred to, comparing the fruit and branches of the healthy, with those of the diseased tree.

Fruit of Early Crawford.

	Healthy. Per cent.	Diseased. Per cent.
Ferric oxide	0.58	0.47
Calcium oxide	2.64	4.68
Magnesium oxide	6.29	5.48
Phosphoric acid	16.03	18.07
Potassium oxide	74.46	71.30
	100.00	100.00

Branches of Early Crawford.

	Healthy. (Restored)	Diseased.
Ferric oxide	0.52	1.44
Calcium oxide	54.52	64.23
Magnesium oxide	7.58	10.28
Phosphoric acid	11.37	8.37
Potassium oxide	26.01	15.68
	100.00	100.00

[1] Observations Regarding the Yellows of the Peach, C. A. Goessmann, Ph. D. Trans. Soc. for Prom. of Agricultural Science, 1882, Montreal.

Digitized by Google

From these analyses, the relative importance of calcium and potasssium oxide is shown in a striking manner; a decrease of the former in healthy structure corresponding very closely with an increase in the latter.

Our studies conducted with the aid of the microscope have served to throw much light upon this subject, and not only have they confirmed the deductions from a chemical standpoint, but they appear to be in accord with the earlier investigations of Nobbe and Schroeder on rye and buckwheat, during which they demonstrated the superior value of chloride of potassium over the sulphate, as establishing in the plant a normal distribution of assimilated material to the growing parts.

Growing upon diseased plants, and often producing by their action, some of the more conspicuous features of the disease, are fungi of various forms. These, however, are such as may be generally found upon decaying organic matter, such as old stumps, and do not belong to that class of fungi generally considered capable of immediately producing disorganization in highly vitalized structures. Moreover, while found upon the outer dead bark, and, under favorable conditions in the interior structure, the same forms occur on both the diseased and healthy trees and what is more striking, they also are to be found upon trees which once badly diseased are now restored to a condition of vigorous health. We are led to believe, therefore, that while these parasitic growths do produce certain well defined effects under certain conditions of the plant, their relation to disease is of secondary importance; we must seek the cause of disorder in conditions of soil and food.

An examination of the cellular structure and cell contents has shown:—

1. Healthy wood shows comparatively little stored starch in the bark.

2. Diseased wood shows an abnormally small development of the cells and the invariable presence of large quantities of starch in the bark and pith.

3. There is little or no difference between the tissues and cell contents before and after the leaves fall.

These conclusions appeared justifiable at a comparatively early stage of our inquiry and have been abundantly confirmed by subsequent examinations. A general predominance of and correspondence between calcium oxalate and stored starch in diseased

Digitized by Google

structures, seems to offer another confirmation of the chemical deductions previously referred to.

It has been customary, until a very recent date, for students to approach the subject of diseases of plants from a strictly botanical standpoint, giving little or no weight to other considerations. The old view, stoutly maintained by some even at the present time, that these diseases originate in fungoid growths, gave rise to the application of certain remedial measures, the aim of which was to arrest disease by destroying the parasite. No successful case of such treatment has yet been recorded.

The new method while recognizing the important connection of parasites with disease, aims first to promote a highly vigorous condition in the plant and thus enable it to throw off the unwelcome guest. Badly diseased trees, treated upon this principle, have been restored to vigorous health and for the past two or three years have borne fruit commanding the best market prices.

From this brief statement and review of the case, it will be apparent that in the future, we must not depend upon either the microscope or the chemist alone, but if we are to obtain a correct solution of these difficult and most important questions, we must unite by rational method the deductions of the chemist with those drawn from microscopic study.

A new form of Constant Pressure Injection Apparatus. By William Libbey, jr., of Princeton, N. J.

In studying the circulatory system, the means of injection are an indispensable aid. This operation can be performed in several different ways, but the most satisfactory method would of course be that which would in the simplest manner utilize the materials used and at the same time place them under the most perfect control of the operator.

In the piece of apparatus described below, the wants of my laboratory have been especially consulted, and the object kept in view was the construction of a machine which would perform the most delicate injections in a satisfactory manner. In a sense, it may be said that this object has been realized; but, as the element

Digitized by Google

of good judgment can never be made part of a machine, the degree of success will still be in proportion to the skill in manipulation. All such machines must have a certain similarity in their construction, but may differ essentially in the arrangement of their several parts, and for this reason no great originality is claimed for the apparatus; the method of the operation in the machine under consideration is as follows:—

We will suppose the animal or organ to be injected to have been prepared as usual and placed over a water bath arranged to secure a proper degree of temperature during the operation; and, the injection mass having been also previously prepared and placed in a three-mouthed wolffs-bottle (prepared as a wash-bottle with closely fitting rubber corks) which should, of course, be placed over a water-bath to keep the mass liquid.

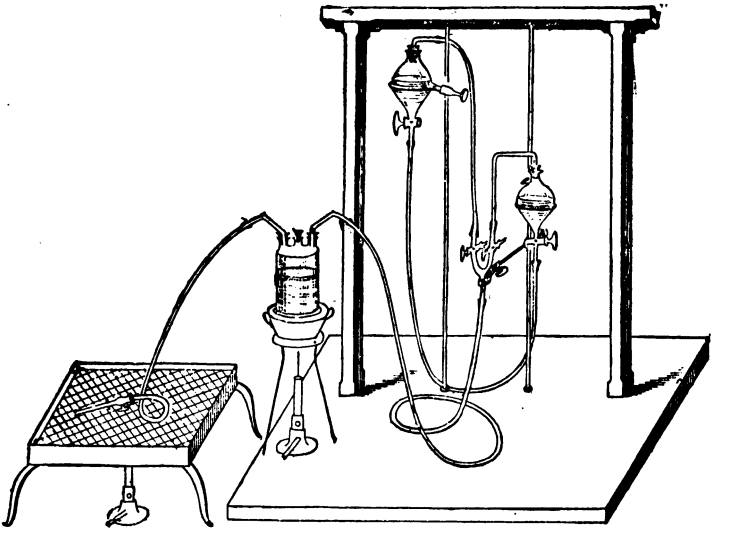
The source of the power utilized is twenty pounds of mercury which, by changing position from a higher to a lower level, forces the air out of one of two glass filtering funnels alternately, as one placed below or raised above the level of the other which should be kept stationary. These two filtering funnels are supported on iron rings with clamps which can be attached to two iron rods at any given height. The iron rods should be about thirty-six inches high being held in their places by a framework that rises on the back part of a wooden platform which rests upon the table (or may be built into the wall, or placed between two shelves far enough apart in a closet in the laboratory) and serves as a convenient place for any accessory apparatus or instruments. The funnels, referred to above, are connected at the bottom of each by a rubber tube, and have stop-cocks above the points where the tubing is attached. The opening at the upper part of these funnels is closed with rubber corks through which a glass tube is placed after having been once bent at right angles.

The means of securing the operation of the currents of air in such a manner as to perform their works properly is an arrangement of three-way-stop-cocks of a peculiar construction. These stop-cocks are each so constructed that when turned in one position they have the form of a regular spigot, while by a quarter turn from that position, a straight connection is made through the body of the stop-cock to a tube opening at that point.

Two of these stop-cocks are placed, one on either of the upward branches of a glass tube having the form of the letter Y. This

Digitized by Google

arrangement affords the means of transmitting a current of air under pressure through that stop-cock which may be turned so as to open a straight connection through it, when that branch of the Y-tube of which it forms a part has been connected with the glass tube at the top of the filtering funnel, from which the air is forced by the flow of the mercury to it from the other funnel which should occupy a higher position. It also affords the means of allowing a current of air to flow to the surface of the mercury in the higher vessel, through the other stop-cock which should be turned so as to afford ingress to the air; this will be secured when the stop-cock



A Constant Pressure Injection Apparatus.

is placed in a position at right angles to that of the first described stop-cock. This branch of the Y-tube should be connected with the tube at the top of the other filtering funnel.

The lower branch of the Y-tube should be connected with the short arm of the bottle containing the injection mass. All the joints made with the tubing should be securely wired and all the other connections made as tight as possible.

The Y-tube described above should be securely supported by extension test-tube clamps, attached to the iron rod, to which the stationary filtering funnel has been fixed, and below the funnel.

Digitized by Google

The long arm of the bottle containing the injection mass should be attached to the nozzle-stop-cock which fits the canulæ to be used in the injection.

Now we shall suppose that the mercury has been placed in the stationary filtering funnel and this latter firmly fixed a little above the middle point of one of the iron rods. The stop-cock of this funnel should be turned so as to prevent the mercury flowing from it, then the three-way-stop-cock connected with it should be turned so that the air may have access to the surface of the mercury, and the other three-way-stop-cock turned so that the air from the funnel with which it is connected will flow directly through the glass-tube to the wolffs-bottle.

Then if the second filtering funnel be placed in a lower position than the first, above described, and clamped securely, the machine is ready for use.

If the mercury should then be turned on it will force the air out of the lower filtering funnel and this air will then act upon the injection mass, forcing it along in proportion to the difference in level of mercury, or the amount of mercury turned on.

If a larger quantity of injection mass is required than can be discharged from the wolffs-bottle by once emptying one funnel into the other, after the flow of mercury has been stopped by turning the stop-cock of the lower funnel, an additional quantity of the fluid can be poured through the central mouth of the wolffs-bottle.

The positions of the three-way-stop-cocks should now be reversed to permit the current of air to act from the other funnel upon the injection mass.

Then the funnel which is full of mercury should be raised to a position on its rod as much above that of the stationary funnel as it was below it before, when it will in its turn become the source of power when the mercury is turned on.

Thus the operation may be proceeded with, and by repeating this simple process an injection may be performed lasting any reasonable time, with very little trouble or interference on the part of the operator and, so far as my experience goes, with great satisfaction.

It will be readily seen that absolute constancy of pressure is not even obtained in this instance because the shifting lines of level of the surface of the mercury, in the firmly fixed funnels, introduce a

Digitized by Google

small error: this might be overcome by suspending the funnels from springs so adjusted that as the mercury changed its level, a compensation would be brought about by a change in the position of the funnels; but after having tried the firmly fixed funnels and not having experienced the slightest difficulty from this source of error, I am inclined to believe that a change would be an almost needless refinement of accuracy and in addition would somewhat doubt the prudence of having such a weight of mercury suspended in that manner.

The piece of apparatus has been thus described, somewhat at length in the hope that histologists will find in it an aid in their investigations such as it has been to myself.

A Filtering Wash-bottle especially adapted to the use of the Histologist. By C. E. Hanaman, of Troy, N. Y.

[ABSTRACT.]

It is a matter of every-day experience, with those who employ the microscope in histological research, that however careful they may be to filter their reagents before the day's work begins, ere long, particles of foreign matter are apt to make their appearance in the various solutions employed.

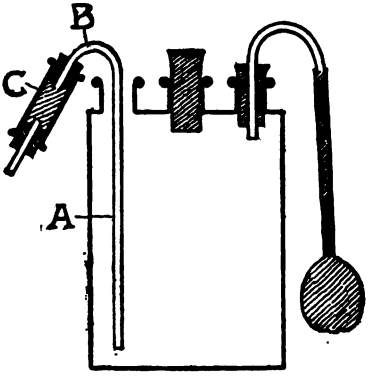
These particles not unfrequently become attached to the most interesting portions of valuable specimens, thereby marring their beauty, and sometimes detracting from their value. I have not found the usual forms of paper and cotton filters as convenient as I could wish, and it was with a view to the production of a simple apparatus, which would deliver as required any quantity, from a single drop to a full dish of any staining fluid or other reagent, that I devised, some two years ago, the apparatus, a description of which is the purpose of this paper.

A bottle with three necks is taken and through a cork in one of the necks is passed a bent glass tube (A) reaching nearly to the bottom (as in the ordinary wash-bottle) but cut off at the upper end a short distance beyond the bend or neck (B). At this point

Digitized by Google

there is attached by a cork, a short piece (say three inches long) of a tube of wider lumen (C) than that used in the long tube (A). Into the open or lower end of the wide tube, is inserted a cork, through which passes a short delivery tube.

Over the corks inserted in either end of the wide tube, and covering the ends of the smaller tubes where they open into the larger one, are stretched pieces of fine muslin, and between the two corks the tube is filled with a rather loosely packed plug of "absorbent cotton." The second or middle neck of the bottle is closed by a well fitting cork. Through a cork in the third neck is passed a piece of bent glass tubing, which reaches just below the cork on the inside of the bottle, and extends (either in the form of an arch, or bent at right angles) a short distance from the top



A Filtering Wash-Bottle.

of the cork through which it passes. Attached to this tube is a piece of rubber tubing of a suitable length, at the end of which, either a short glass mouth-piece, or the rubber bulb of a Davidson syringe is attached. To use the apparatus the bottle is filled, through the middle neck, half or two-thirds full of the reagent to be employed and the cork is again firmly inserted. It will then be found, that by compressing the rubber bulb, or blowing through the mouth-piece, the air in the bottle will be condensed and the fluid will be driven through the cotton plug, either in drops or in a stream, according to the quantity of air forced into the bottle. A very gentle squeeze of the bulb, or a gentle breath at the mouth-piece, and a single drop is delivered, while by rapidly condensing the air with the bulb, a stream will flow from the delivery

Digitized by Google

tube, which can be instantly stopped when the desired quantity has been obtained, by simply loosening the cork in the middle neck. When the plug of cotton becomes foul, as it will after a time, the cork in the lower end of the wide tube is taken out and the plug pulled out with a bit of bent wire, and a fresh one substituted.

The same plug may be used for a long time with most reagents before renewal is required. With reagents like $\frac{1}{2}$ per cent or $\frac{3}{4}$ per cent salt solution, in which the strength of the solution would be altered by condensation in the cotton plug, a daily renewal may be necessary, but with even so troublesome a reagent, as the Hæmatoxylin staining fluid, the plug will not require renewal oftener than once or twice a week, when used daily.

The convenience of the apparatus will I think be apparent to all, and I hope may prove to be as great a source of comfort to others as it has been to myself.

Development of the Planula of Clava leptostyla, Ag. By J. H. Pillsbury of Springfield, Mass.

[ABSTRACT.[1]]

After referring to the habitat of this hydroid the author gave a brief description of the familiar method of its development from the formation of the germinal dot to the escape of the planula from the sporosac. The special point to which the author wished to call attention is the fact that the cilia are developed before the planula bursts forth from the sporosac, a fact which has been either overlooked or denied by previous observers, and the probable service the ciliary motions render in accelerating the escape of the planula.

[1] Published in full in the American Monthly Microscopical Journal, for October, 1882.

Digitized by Google

TITLES OF OTHER PAPERS READ IN SECTION G.

On a new form of dry mounting. By Wm. A. Rogers of Cambridge, Mass.

A study of the problem of fine ruling with reference to the limit of naked eye visibility and microscopic resolution. By W. A. Rogers of Cambridge, Mass.

On the epidermis of Marsipobranchs. By Albert H. Tuttle of Columbus, Ohio.

The house-fly considered in relation to contagious poisons. By Thomas Taylor of Washington, D. C.

A new freezing machine for section cutting. By Thomas Taylor of Washington, D. C.

Demonstration of the Bacillus of tuberculosis. By William Osler of Montreal, Canada.

Digitized by Google

SECTION H.

ANTHROPOLOGY.

Digitized by Google

Digitized by Google

ADDRESS

BY

DANIEL WILSON, LL.D., F. R. S. E.,

VICE PRESIDENT, SECTION H.

SOME PHYSICAL CHARACTERISTICS OF NATIVE TRIBES OF CANADA.

In welcoming the Anthropological Section of the American Association for the Advancement of Science to its meeting here on Canadian soil, it will not, I trust, appear unsuitable to the occasion, if I invite attention to some of the physical characteristics which distinguish certain native races of the Dominion; and especially to the significance of certain typical head-forms, and their bearing on our special researches in reference to the origin, distribution, and classification of races.

In so doing, it is important to keep in view the prevalence throughout the American continent of various artificial modifications of skull-forms. This strange custom is probably at the present time carried on more systematically among the different tribes of Flathead Indians of British Columbia, than in any other region; though abundant evidence exists to show its prevalence both in past and present times among many tribes and nations in very different stages of progress, alike in North and South America. It has, indeed, attracted more general attention than most other characteristic practices of the American aborigines, owing to its prevalence alike among the most barbarous and the most civilized races. To all appearance the Peruvians and Mexicans had devel-

Digitized by Google

oped independent phases of progress in arts, science, and social policy, without any knowledge of each other. Nevertheless, we trace the singular practice of moulding the human head into abnormal forms, alike among the civilized races of Peru, the ancient lettered architects of Central America and Mexico, and among barbarous tribes both to the east and west of the Rocky Mountains. The earthworks of the Mississippi Valley Mound-builders have been found to cover artificially flattened crania; and the student of American native civilization, as he turns from pondering over the bas-reliefs and hieroglyphics on the sculptured slabs of Palenque and Uxmal, is startled to find that the cranial forms and strange physiognomical contour of the architectural race of Central America are reproduced among some of the most barbarous living tribes of Oregon and British Columbia. But, now that the study of craniology has been carried out by many intelligent observers, the fact is becoming familiar to us that artificial cranial deformation is no peculiarity of the American continent, either in ancient or modern times. The compressed crania of the Asiatic Macrocephali attracted the attention of Hippocrates five centuries before the Christian era; and Blumenbach, the foremost of European craniologists, figured in the first fasciculus of his "Decades Craniorum," in 1790, an imperfect compressed skull, received by him from Russia, with the information that it was probably that of a Tartar. This he unhesitatingly designated an Asiatic Macrocephalus. The conclusion thus arrived at has been sustained by subsequent discoveries; and as attention is more widely directed to the general subject the results are found to have a special value for the American ethnologist.

It seems probable that the name of Macrocephali, like that of our own Flatheads, did not properly belong to any single tribe, or even distinct race of ancient Asia; but had its origin in the effort, by artificial means, to produce the patrician head-form, primarily characteristic of some dominant, or conquering race. Among the Chinooks and other Flathead tribes of this continent, and also, as I believe, among the ancient builder-races of Yucatan and Peru, certain head-forms were recognized as an attribute of the ruling cast. Within the Flathead area of British Columbia the compressed and distorted skull is even now the symbol of aristocracy; and adopted captives, or slaves, are precluded from giving the prized deformity to their offspring. Hippocrates refers in

Digitized by Google

his "De Aere, Aquis, et Locis," to the Macrocephali as a people among whom "those are thought the most noble who have the longest heads." Skulls of this type have been recovered in recent years from ancient graves in the Crimean Bosphorus, and the valley of the Don. Still more illustrative of the effort at superinducing a novel dolichocephalic form among races of brachycephalic type, are the examples of compressed Hun or Avar skulls found from time to time on the line of march of the great Hunish invasions of Europe in the fifth and sixth centuries. One of the first examples of such mediæval compressed crania which attracted special attention in Europe was a skull found, in the year 1820, at Fuersbrunn, near Grafenegg, in Austria. Count August von Breuner, the proprietor of the soil, acquired possession of the interesting relic, and at once ascribed it to the Avarian Huns, who occupied that region from the middle of the sixth until the eighth century. Of this compressed Avar skull, Retzius gave a description in the proceedings of the Royal Academy of Sciences of Stockholm, in 1844; and showed that the skull, which had been regarded as remarkable for its great elongation, was in reality a true brachycephalic skull, such as the Mongol affinities of the Avars would suggest, but that by artificial compression it had been elongated, vertically, or rather obliquely. An additional interest is conferred on this European example of artificial cranial deformation by the fact that scientific observers were persuaded for a time to regard it, not as European, but as an intrusive American example, brought thither soon after the discovery of this continent. The well known traveller Dr. Tschudi communicated to Müller's "Archiv für Anatomie" a memoir, in which he instituted a comparison between this Grafenegg skull and the compressed crania of ancient Peruvian cemeteries, whence he arrived at the conclusion that scientific men had been deceived in ascribing to any Asiatic or European source a skull which must have been originally derived from Peru. In confirmation of this, he recalled the fact that, widely as Austria and Peru are now severed, in the sixteenth century the Emperor Charles V embraced both within his dominions. He accordingly conceived it no improbable conjecture that the compressed skull was brought to Europe, as an object of curiosity; and being afterwards thrown aside, it was mistakenly assumed to pertain to native sepulture when recovered at Fuersbrunn in the present century.

Digitized by Google

More recent discoveries of artificially compressed crania on European sites, have removed all doubts of their native, or intrusive Asiatic origin. It thus appears that the barbarous practice is neither recent, nor peculiar to the New World. Neither to America nor to Europe do those examples of mediæval and ancient compressed crania really belong, but seemingly to the nomad Mongols and Ugrians of the steppes of Northern Asia, in the vast wilds of which we lose them as they spread away eastward toward the Okhotsk Sea and the Aleutian Islands. We are thus guided by unmistakable indications backward, as it seems, on this ancient trail, down the valley of the Danube, and beyond the Caspian and the Ural Mountains, to a region outside the farthest limits assigned by Hippocrates, Strabo, Pliny, or Mela, to the Asiatic Macrocephali; and recover traces of the strange practice of the American Flatheads far to the northeast of the Altai chain, in the valleys that skirt the Yablonoi mountains, as they trend eastward towards the Okhotsk Sea. It may indeed be an American practice which Asia borrowed, for the affinities of race between the tribes of the islands and Asiatic mainland immediately to the west of Behring strait point to a migration to Asia from America. Such, however, is limited and exceptional. On evidence which embraces the ethnical characteristics of a very wide Asiatic area, the Mongolian classification of the American Indian is confirmed by many significant points of resemblance in form, color, texture of hair, and peculiar customs and traits of character, which fail us when we turn either to the Asiatic Aleutians, the Namollos, and other allied tribes of the older continent, or to the true Eskimo. The striking resemblance noted by Humboldt as existing between the American race and the Mongols of Asia, received independent confirmation from Dr. Charles Pickering, as the result of his extensive observation of the races of both continents, in his capacity of ethnologist to the American Exploring Expedition. Such affinities are still further confirmed, as we recover the traces of the singular practice of cranial deformation extending in ancient and mediæval times eastward from the Euxine and beyond the Altai mountains. To those little-known areas of northern Asia the ethnologist and the archæologist have yet to turn in quest of the footprints of one of the immigrant routes to the new world. There it is, in the vast unknown regions of Asiatic Russia, that we may hope to recover evidence confirmatory of at least one source of the Asiatic relations of the American race.

Digitized by Google

It is now a recognized fact that the artificial head-forms characteristic of diverse tribes of North and South America vary greatly, from the extreme depressed forehead and laterally compressed skulls of races that rivalled the ancient Macrocephali in their estimation that "the most noble are those who have the longest heads," to some among the Cowlitz or Chinook tribes of British Columbia, whose heads are compressed into a flattened disk. The two artificial extremes find their analogues in the distinct ethnical divisions of dolichocephalic and brachycephalic head-forms among well-known northern tribes. The predominant natural form, characteristic of the more southern tribes of North America, appears to have been brachycephalic, or, as it is sometimes called, globular. But along the regions of the great lakes, in the valley of the St. Lawrence, and northward throughout the whole Eskimo area, the dolichocephalic head-form prevails. The native races of the Dominion, and especially the earliest known aborigines of Upper and Lower Canada, including the province in which you are now met, appear to have been all of the same dolichocephalic type; and so to have formed a class markedly distinct from the short, or globular headed races of the south, whose head-form was long regarded as typical of the whole American race. Of the Indians of Hochelaga, first met by Cartier, in 1535, we are able to judge from crania recovered from their cemeteries. The palisaded Indian town of Hochelaga occupied, in the sixteenth century, the site where we are now assembled; and in the museum of McGill College may be seen examples of the crania, as well as specimens of the flint implements and pottery dug up on its site. Its traces revealed nothing suggestive of any other rudiments of civilization than have long been familiar to the American student of primitive arts in the abundant remains of Indian settlements throughout the area of the eastern States, and on the sites of the Iroquois Confederacy in the State of New York. Their earthenware pots and bowls of various sizes were decorated with rude yet tasteful incised patterns; and the handles were further ingeniously modelled at times into human and animal forms. Tobacco pipes also, both of stone and earthenware, here as elsewhere, were special objects of artistic ornamentation. Stone and flint implements, bone needles and bodkins, also abounded; but of metal only very rare traces of the cold-wrought copper tool gave any indication of even the first rudiments of metallurgic art. In truth, Canada has no such evidences, even of

Digitized by Google

an incipient native civilization, as the remarkable earthworks which abound in the great river valleys to the south of Lake Erie. To all appearance, through unnumbered centuries, the tide of human life has ebbed and flowed, to the north of these great lakes, and in the valley of the St. Lawrence, as unprogressively as on the great steppes of Asia, among the Bedouin tribes of the Arabian peninsula, or around the tropical lakes of equatorial Africa. Such footprints as the wanderers have left on the sands of time tell us no more than the ripples on the sea beach, and are indeed still more evanescent. Nevertheless, in all their distinctive characteristics, the tribes of our Canadian forests and prairies present much in common with those by whom the whole area of this northern continent, southward to the Gulf of Mexico, appears to have been occupied when first brought under the notice of European explorers.

It is indeed a noticeable fact in reference to the entire population of this western hemisphere, throughout areas so widely differing in climate and physical geography as are embraced within the region extending from the arctic circle to Terra del Fuego, that the ethnical diversities are slight when compared with those which pertain to what, historically speaking, are the older continents. It seems to force on us the conclusion that, however remotely we may trace our way back into unrecorded centuries, ere we reach the time when man made his first appearance here, so far as the multiplication of diverse racial varieties afford any evidence, it is recent when compared with the peopling of the ancient world. To this indeed one important exception has been suggested in the assumption of a direct affinity between the hyperborean tribes of this continent and the men of Europe's palæolithic era; and I shall accordingly refer to it in its bearings on the general conclusions to which we are thus led.

Great, however, as is the superficial resemblance which seems to pervade the diverse tribes of the American continent, some of the underlying differences were noted from the first. Columbus, with an eye quick to discern all that was peculiar in the novel scenes on which he was the first to gaze, failed not to note the marked distinction between the fair complexion of the Guanches, who were brought under his notice on his first voyage, and the reddish-olive of the ferocious Caribs. Apart from this purely physical distinction, these Guanches attracted his attention by their gentle manners and inoffensive habits. From them he learned

Digitized by Google

of the Caribs, as a fierce, warlike people occupying the neighbouring islands and the mainland, of whom they lived in constant dread; and who subsequently became familiar to the Spaniards as a ferocious, crafty, and revengeful race, delighting in cannibalism. Hence we perceive that from the first both physical and moral differences, of a sufficiently marked character, were observed among native tribes of the New World. Nor indeed did Humboldt, or even Morton, entirely overlook the existence of considerable varieties in color and complexion, from nearly white to a dark brown; though they were led, from different causes, to underestimate the extent of diversity prevailing among the widely scattered nations of North and South America.

But while it is deserving of notice that the aborigines of Canada do differ in certain physical characteristics from those especially of the more southern states of North America, it is undoubtedly true that an approximate correspondence in ethnical characteristics is common to many tribes both of North and South America. It is not, therefore, to be wondered at that the idea of their constituting one native stock distinct from all the races of the Old World, and agreeing in the possession of physical characteristics peculiar to themselves, should have been accepted for a time as indisputable. The vague generalizations of travellers, and the current forms of popular belief, however, gradually acquired consistency as an accepted canon of ethnical science; until, in the final embodiment of Dr. Morton's matured opinions, he affirmed the American race to be essentially separate and peculiar, and with no obvious links, such as he could discern, between them and the people of the old world, but a race distinct from all others.

The geographical facilities for intermixture among the very diverse races of Asia, Africa, and Europe, account for many intermediate and transitional races; but this increases rather than diminishes the difficulty of referring to any satisfactory source, such primary types of extreme diversity as the Negro, Berber, Mongol, Malay, Arab, and Saxon. Here, on the contrary, so far as now appears, approximate types were hemmed in between the Atlantic and the Pacific; and in so far as they intermingled, the tendency necessarily was to diminish, if not to efface, any strongly marked distinctions; just as, in prehistoric centuries, the blending of the aboriginal savage with intruding races is assumed to have begot-

Digitized by Google

ten the Melanocroi and the Xanthocroi of Europe's ethnological classification.

Here, undoubtedly, as well as in Europe and Asia, extreme diversities have been modified; but from the first these differences must have extended over a narrower range on the American continent than that which finds such curious illustration in the ancient sculpture and paintings of the Nile valley. The baso-relievos of Yucatan, the terra cottas of Mexico, and the pottery of Peru, furnish analogous evidence of considerable diversity of type among the prehistoric, as well as the historic and civilized races of the New World. Nevertheless, after the fullest recognition of all that such evidence indicates, the fact remains that great as is the divergence of the Eskimo from the Mexican, or the Peruvian from the Patagonian, the difference becomes almost insignificant in comparison with that which distinguishes the Aryan Hindo from the Andaman Islander, the Arab from the Chinese, or the insular Malay from the Negritto. Yet all of those pertain to a continent which is only separated from our own by Behring Strait. So noticeable indeed is the prevailing correspondence in ethnical characteristics among the various races of this continent, that the elements of diversity were long overlooked, even by acute scientific observers. Malte Brun affirmed as the result of a long course of observation, "that the Americans, whatever their origin may be, constitute at the present day a race essentially different from the rest of mankind." A more notable authority, possessed alike of rare capacity for accurate discrimination, and of opportunity for extended personal observation,—the distinguished scientific traveller, Humboldt,—remarked in the preface to his "Researches:" "The nations of America, except those which border the polar circle, form a single race, characterized by the formation of the skull, the color of the skin, the extreme thinness of the beard, and the straight glossy hair."

Until very recent years this was accepted as no less indisputable than any axiom of Euclid. American ethnologists were agreed as to the predominance of one ethnical type throughout the whole western hemisphere; while those of Europe, with rarer opportunities for personal observation, were predisposed by all the narratives of early voyagers to accept the conclusion that the man of the New World was a well-defined variety, if not a distinct species, of the genus *Homo*. Prichard, Lawrence, Wiseman,

Digitized by Google

Knox, Morton, Agassiz, Squier, Gliddon, Nott, and Meigs, might each be quoted in confirmation of this opinion, and especially of the prevailing uniformity of certain strongly-marked cranial characteristics. Agassiz, for example, affirmed in very explicit language: "with the exception of the Arctic Esquimaux, there is only one single race of men extending over the whole range of North and South America, but dividing into innumerable tribes; whilst, in the Old World, there are a great many well-defined and easily distinguished races, which are circumscribed within comparatively much narrower boundaries." Morton, again, viewing the subject in the light of his own special evidence, designated a markedly brachycephalic skull, with flattened occiput, recovered from one of the mounds in the Scioto Valley, "an aboriginal American head," and added: "this is, perhaps, the most admirably formed head of the American race hitherto discovered. It possesses the national characteristics in perfection." Accordingly, after indicating these in detail, he affirms: "it is the perfect type of Indian conformation, to which the skulls of all the tribes from Cape Horn to Canada more or less approximate."

Among what may be designated typical Canadian skulls, those of the Hurons of the region lying around the Georgian Bay have a special value. They represent, as we believe, a native race which, under various names, extended from the Lower St. Lawrence westward to Lake St. Clair, the *Ouane-doté:* including the Petuns, Neuters, Hurons, Eries, and other Wyandot tribes, of the same stock as the Iroquois; but to whose implacable enmity their extermination was ultimately due. The native population first met with by Cartier and the French explorers of 1535, is believed to have been of the same Wyandot stock; but before the return of the French under Champlain, in 1603, they had been exterminated, or driven westward to the later country of the Hurons, on the Georgian Bay. There they were first visited by Champlain in 1615, and subsequently by the French Jesuit missionaries who, in 1639, found them occupying thirty-two palisaded villages. Brébœuf reckoned their number in 1635 at thirty thousand, and they are estimated, in the "Relation" of 1660 at thirty-five thousand. Already, at that early date, the whole country westward from the Ottawa to the Huron country around Lake Simcoe, had been depopulated, and reduced to a desert, by the wrath of the Iroquois. Charlevoix assigns the year 1655 as that of the destruction of

Digitized by Google

the Attiwendaronks, or Neuters, who occupied the fertile Niagara peninsula between Lake Erie and Lake Ontario; and the Eries, whose name is perpetuated in the great lake on whose shore they dwelt, had already been exterminated by the violence of the same kindred race, before the French explorers had even ascertained the existence of the lake which bears their name. In the earlier French maps an imaginary river extends uninterruptedly from Lake Huron to Lake Ontario.

Minute information has been preserved of the Hurons in their later home, derived chiefly from the "Relations" of the Jesuit Fathers, communicated to the Provincial of the Order at Paris, from 1611 to 1672. We thence learn accurate details of their great "Feast of the Dead" celebrated at intervals of ten or twelve years, when the remains of their scattered dead were gathered from old scaffolded biers, or remote graves, and deposited with grand ceremonial and mourning in the general cemetery of the tribe. In the vicinity of the sites of their palisaded villages extensive ossuaries have repeatedly been found; and there are now preserved, in the museum of Laval University at Quebec, upwards of eighty skulls recovered from the Huron cemeteries of St. Ignace, St. Joachin, St. Mary, St. Michael, and others of the Huron villages, so designated by the French Missionaries who visited them in the seventeenth century, and labored for the conversion of the Indians there. Other examples are preserved in the museum of Toronto University; and I may add that Dr. Taché, by whom the most extensive researches were carried on, presented ten Huron skulls to the London Anthropological Society; and I have since forwarded specimens to Dr. De Quatrefages for the museum of the Jardin des Plantes at Paris.

A special value attaches to the skulls recovered from those Huron ossuaries, from the fact that the race was exterminated, or driven out of the country, by their Iroquois foes, in 1649: and hence the crania recovered from their old cemeteries may be relied upon as giving a fair illustration of the physical characteristics of the race. The descendants of a small band of Huron refugees, rescued from the general massacre, and brought by the French missionaries to Quebec, still survive at the Huron village of Lorette, on the St. Charles River; but they have long since lost the pure traits of full-blood Indians, and are chiefly interesting to the ethnologist now from the evidence they give of the

Digitized by Google

survival alike of native intellectual and physical traits, after an interval of well nigh two centuries and a half passed in intimate intercourse, and latterly frequent intermarriage with the French habitans.

The Huron skull is strongly marked as of the dolichocephalic type. The careful measurements of thirty-nine male skulls yield a mean longitudinal diameter of 7.39 to a parietal diameter of 5.50; and of eighteen female skulls, a longitudinal diameter of 7.07 to a parietal diameter of 5.22. One essential characteristic, therefore, that of great relative length, is unmistakable. I specially refer to this now, because we possess, in the collection of the Canadian Institute at Toronto, a skull recovered from one of the Huron ossuaries near Lake Simcoe which differs essentially from this Huron type. It is a short skull,— shorter even than that from the Scioto mound,— of the same, so-called, globular type, measuring only 6.00 in longitudinal, and 6.40 in parietal, diameter. Reverting, therefore, to Dr. Morton's ascription to the Scioto mound skull of national characteristics, which constitute it "the perfect type of Indian conformation, to which the skulls of all the tribes from Cape Horn to Canada more or less approximate," this northern example, if it stood alone, would seem to confirm his assumption. But it is a wholly exceptional case; so distinct from the true Huron type that, after a careful study of one hundred and twenty-six crania from ossuaries of the Huron country, including considerable deviations from what may be regarded as the normal type, I have not found one other example approximating to it. It differs little less essentially from the race-form of the people whose grave its owner shared than that of a Chinese from the normal skull of the pure Anglo-American; and may be assumed as that of an Indian belonging to some far southern tribe, whom the chances of Indian warfare had made a captive, or an adopted member, of the Huron tribe in whose cemetery he found his final resting-place.

Such indications of physical diversity, among the nations so widely scattered throughout the New World, accord with philological and other evidence. Not by one, but by diverse routes have the fathers of the American nations found their way thither: some by Behring Strait and the Aleutian Islands; others by more southern routes across the broad Pacific, aided by winds and currents, and passing onward from island to island of the great archipelago; others, as we know, by Iceland and Greenland, across

Digitized by Google

the northern Atlantic; and others again—as philological evidence seems to indicate,—along the same route as that which Columbus successfully pursued in 1492. But to the primary migrations we know not how remote a date to assign, in order to allow of the interblending of intruding races, and the development of the native American "Red Man" with all his distinctive traits of individuality. For, while it is important to note the elements of diversity, it is nevertheless true that the New World does differ from the Old in the narrow range of such variations of race-type through all extremes of climate from arctic to temperate, tropical, and antarctic. The European traveller who surveys his own continent from the northern habitat of the Fins and Lapps, and the corresponding Asiatic hyperboreans, and then traverses the eastern hemisphere to the Cape or to the Indian Ocean, comes in contact with all intermediate varieties between the two extremes of the white and black races; and recognizes in western Europe the Melanocroi who seem to be the resultant of their inter-blending in prehistoric times. But in America we seem to see no more than a result analogous to the latter; and this as the product of more nearly allied primitive stocks, the largely preponderating element of which has been derived from the Mongol area of eastern Asia. Philological evidence, on the other hand, no less clearly indicates the remoteness of the migrations by which this first colonization of the New World was effected; it may be, indeed, that they pertain to periods when the physical geography of both continents, and of the intermediate archipelago, afforded facilities for migration altogether wanting within historic times.

But such ideas of a derivative origin of the American aborigines are of very modern growth, and are only now displacing long accredited beliefs. That the man of this New World must prove a being essentially different from any known race of Europe, Africa, or Asia, was an opinion which assumed ever stronger confirmation, as the idea of Columbus that he had landed on the eastern Continent faded away from the minds of his successors. The Indians of his new-found world were no natives of Cipango, or the valley of the Indus; and the literature of the fifteenth and sixteenth centuries abounds with evidence that it was much easier to persuade the men of that age that Calibans and monstrous Anthropophagi peopled the strange regions beyond the Atlantic, than that these were inhabited by human beings like themselves.

Digitized by Google

Even Columbus, it has to be remembered, in searching for evidence to confirm his own scientific demonstration that the world was a sphere, and so, that the eastern continent could be reached by a western route, attached special value to indications of the existence of a transatlantic continent, derived from the fact that the bodies of two dead men had been cast ashore on the island of Flores, differing essentially in features and physical characteristics from any known race. When, at length, the great discoverer set foot on the islands first visited by him, the peculiarities which marked the gentle and friendly race of Guanahanè were noted with curious minuteness; and their "tawny or copper hue," their straight, coarse, black hair, strange features, and well-developed forms, were all recorded as objects of interest. On his return, the little caravel of Columbus was freighted not only with gold and other coveted products of the New World, but with nine of its natives, brought from the Islands of San Salvador and Hispaniola, eight of whom survived to gaze on the strange civilization of Spain, and to be themselves objects of scarcely less astonishment than if they had come from another planet. Such was the earliest knowledge acquired by the Old World of the type of humanity generically designated as the Red Indian; and the attention which its peculiarities excited when thus displayed in their fresh novelty has not yet exhausted itself, after an interval now little short of four centuries.

Of all known races of the New World, the Eskimo alone presented, at first, a seemingly marked diversity from the other aborigines; though the grounds on which such a conclusion was based are traceable far more to Arctic conditions of life, than to any ethnical peculiarities definitely assigned to them.

This is apparent from the terms employed by the historian Robertson, who, writing in 1777, says: "The Esquimaux are manifestly a race of men distinct from all the nations of the American continent, in language, in disposition, and in habits of life. But among all the other inhabitants of America there is such a striking similitude in the form of their bodies, and the qualities of their minds, that, notwithstanding the diversities occasioned by the influence of climate, or unequal progress of improvement, we must pronounce them to be descended from one source."

The idea thus definitely set forth by the Scottish historian of the last century was placed on what seemed to be a strictly scientific basis by the author of the "Crania Americana." Dr. Morton's dili-

Digitized by Google

gence in the accumulation of evidence merits our highest gratitude. But he had unfortunately set out with the idea of one nearly uniform race peculiar to the New World; and with all the evidence before him which has since sufficed to convince others of the prevalence of great diversity of head-forms among American races, he persisted to the close in maintaining the physical unity of the Red Race from the arctic circle to Cape Horn.

Of the three propositions with which Dr. Morton sums up the results borne out, as he conceives, by all the evidence advanced in his "Crania Americana," one is, "That the American nations, excepting the polar tribes, are of one race and one species, but of two great families, which resemble each other in physical, but differ in intellectual character." Any difficulty arising from physical or other differences, he sought to overcome by the application of the hypothesis that "these races originated in *nations*, and not in a single pair; thus forming proximate but not identical species." Subsequent to his death his collection of crania was acquired by the Academy of Natural Sciences of Philadelphia, and thereafter supplemented in its most important branches by many valuable additions. This greatly augmented collection was classified anew and catalogued by the late Dr. J. Aitken Meigs; and after having thus had all the evidence which it presents brought in systematic order under his own notice, he contributed to Gliddon's "Indigenous Races of Men," a paper entitled "Cranial characteristics of the Races of Men," in which he thus reiterated the Mortonian dogma: "Through *Crania Americana*, it has long been known to the scientific world that a remarkable sameness of osteological character pervades all the American tribes from Hudson's Bay to Terra del Fuego. It is equally well known that the researches of Humboldt and Gallatin have demonstrated a conformity not less remarkable in the language and artistic tendencies of these numerous and widely-scattered aborigines."

The artificial transformations of the Indian head were at first a source of difficulty in any systematic classification of head-forms; and the views of Dr. Morton underwent considerable modification on some points relating to the influence of this custom in perpetuating certain types of head; but he finally reverted to the original idea of one predominant cranial type to which all the races of the American continent more or less nearly approximated.

The evidence which the mediæval European examples of cranial

Digitized by Google

deformation supply suggests the origin of this barbarous practice in an aim at conformity with the natural head-form of a patrician or conquering race. Dr. Fitzinger, who has carefully investigated the whole subject of the discovery of macrocephalic skulls in ancient Austrian sepulchral deposits, after tracing the evidence supplied by the allusions of classic writers, mentions an interesting independent illustration of the subject. A medal, struck apparently to commemorate the destruction of the town of Aquileia, by Attila the Hun, in the year 452, came under his notice. On one side is represented the ruined city, and on the other the bust of the Hunish leader in profile, with the same form of head as that shown in the supposed Avar skulls found in the valley of the Danube. One of this type obtained by M. Hippolyte Gosse, from an ancient cemetery in Savoy, presents the favorite Hun or Avar form when viewed in profile, with the singular vertical elongation which appears to have constituted an ideal type of masculine beauty among the Asiatic followers of Attila, as among the Natchez, the Peruvians, and other nations of the New World. It was found at Villy, near Reigner, and has been engraved by Retzius, from a drawing furnished to him by the discoverer.

Thierry, in his "Attila," refers to the artificial means resorted to by his followers in order to give a Mongolian physiognomy to their children. The Hunish leader welcomed every able bodied recruit to his standard, and was in reality as much a leader of Goths as of Huns; though the black Huns from the dreary Siberian steppes constituted the aristocracy of his wild followers, whose Mongolian physiognomy formed the ideal of ethnic beauty. At this the Gothic mother accordingly aimed, by bandaging the nose, compressing the cheek bones, and giving an artificial form to the cranium of her infant. Such practices, however, when once brought into general use, continue long after the reason for their adoption has ceased. It need not therefore greatly surprise us to learn that the practice of distorting the skull in infancy still prevails in some districts of France. Among the examples of such cranial malformation engraved by Dr. Foville, in his work on the "Anatomy of the Nervous System," there is one which might take its place alongside of some of the most exaggerated specimens brought from Peruvian cemeteries.

But however the Gothic mother might labor to make the natural development of her infant's head conform to the Mongolian model,

Digitized by Google

the traces of the originally dolichocephalic type could not be wholly eradicated. This is seen on comparing examples in any large collection of American Indian skulls. In the compressed and distorted Peruvian crania, traces of two distinct types appear to me still uneradicated. The same is noticeable in the sculptures of Central America, as in the Palenque bas-reliefs where deities and chiefs treading kneeling figures underfoot, present the long, sloping forehead in a line with the straight nose, with other features of the strange profile peculiar to the old race; while the subject race is hook-nosed, with high foreheads, and heads seemingly uncompressed. If the idea is well-founded, which thus traces the origin of this barbarous practice to the efforts of an inferior, or subject race to approximate in outward appearance to the privileged class, its very occurrence points to the existence at some previous time of races essentially diverse in physical character. And if we assume their relative positions to have been akin to that of the conquering Hun and the enslaved Frank or German, the motive to such a practice is sufficiently obvious. Were it possible for the colored population of Canada and the United States, at the present day, by any analogous process to assimilate their offspring to the Anglo-Saxon type, how irresistible would the motive be to its use.

Such ideas, however, found no favor with the author of the "Crania Americana;" and in some of the conclusions finally adopted by him he has been sustained by authorities of just weight in science. In the latest record of his matured views, as set forth in a posthumous paper contributed to Schoolcraft's "History of the Indian Tribes," he remarks: "I at first found it difficult to conceive that the original rounded skull of the Indian could be changed into this fantastic form; and was led to suppose that the latter was an artificial elongation of a head remarkable for its length and narrowness. I even supposed that the long-headed Peruvians were a more ancient people than the Inca tribes, and distinguished from them by their cranial configuration. In this opinion I was mistaken. Abundant means of observation and comparison have since convinced me that all these variously formed heads were originally of the same rounded shape."

In that same final contribution to his favorite science, Dr. Morton's matured views on the whole subject of the cranial type of the American continent—based on the additional evidence accumulated by him, in the interval of twelve years which elapsed

Digitized by Google

between the publication of the "Crania Americana" and his death,—are thus defined: "The Indian skull is of a decidedly rounded form. The occipital portion is flattened in the upward direction, and the transverse diameter, as measured between the parietal bones, is remarkably wide, and *often exceeds the longitudinal line.*"

It is curious to observe in this latter statement the evidence of a careful and most conscientious observer allowing all the proofs of varying physical type which his own indefatigable industry had accumulated, to be subordinated to this foregone conclusion. Here Dr. Morton must have had in view his theoretical type, rather than the results of his own careful observations, for even if he accepted as evidence the artificially abbreviated and flattened skulls, his "Crania Americana" furnishes only one exceptional example, from a mound on the Alabama river (Pl. LIV), of which he says: "It is flattened on the occiput and os frontis in such a manner as to give the whole head a sugar-loaf or conical form, whence also its great lateral diameter and its narrowness from back to front." The idea had, in fact, received nearly universal acceptance that the European immigrants of the fifteenth and subsequent centuries intruded upon races of wholly distinct origin from themselves, and were displacing the true American autocthones, with whom they had nothing in common.

When Prior Fernando de Talavera of Salamanca summoned a meeting in the Convent of San Estebán, in the year 1487, to take into consideration the proposition of Columbus that the earth was not a plane, but a sphere; and that, by sailing in a western course, land, which he assumed must be the most eastern coast of Asia, would be reached: the assembled philosophers and theologians gravely pronounced the idea of the earth's spherical form heterodox, and a belief in antipodes incompatible with the historical traditions of our faith; since to assert that there were inhabited lands on the opposite side of the globe, would be to maintain that there were nations not descended from Adam, it being impossible for them to have passed the intervening ocean!

We smile at the orthodox philosophers and theologians of the fifteenth century, who, with the help of St. Jerome and St. Augustine, proved this western hemisphere of ours to be an impossibility; yet it is curious to detect the same old prejudices unconsciously influencing the minds of some of the acutest men of science in very recent years. What else was it, if not this "im-

Digitized by Google

possibility for them to have passed the intervening ocean," or in other words, to have sprung from the same stock, which led one of our own most valued associates, the late Professor Agassiz—a scientific observer of rare sagacity and experience, and one who regarded the entire question of American ethnology from a point of view peculiarly his own,—to adopt the conclusions of Dr. Morton, in spite of the palpable inconsistency of the evidence which he was so well qualified to estimate at its true worth? In his "Sketch of the Natural Provinces of the Animal World, and their relation to the different Types of Man," while appealing to the results arrived at by Dr. Morton, in reference to the imagined unity of the whole American aborigines as "a single race," he reaffirms the homogeneous characteristics and ethnic insulation of the American Indian on entirely novel grounds. After defining the evidence on which his general conclusion is based, that the boundaries within which the different natural combinations of animals are circumscribed on the surface of the earth coincide with the natural range of distinct types of man, he proceeds to show that America, including both its northern and southern continent, differs essentially from Europe and Asia, or Africa, in being characterized throughout by a much greater uniformity in all its natural productions, than comparison enables us to trace in the Old World. He then adds: "With these facts before us, we may expect that there should be no great diversity among the tribes of man inhabiting this continent; and indeed the most extensive investigation of their peculiarities has led Dr. Morton to consider them as constituting but a single race, from the confines of the Esquimaux down to the southernmost extremity of the continent. But, at the same time, it should be remembered that, in accordance with the zoological character of the whole realm, this race is divided into an infinite number of small tribes, presenting more or less difference one from another."

It is interesting thus to recall the matured opinions of this leader of scientific thought among ourselves in very recent years, and review them now in the light of the great revolution since wrought in the entire compass of ethnical and biological science. The author of the "Indigenous Races of Men" scornfully assailed "the Monogenists' idea" of a unity of race, and summed up the practical results which to him appeared to be settled beyond farther cavil, with this fancied demonstration: "It has been shown, 1st, that in America, humatile men and humatile monkeys occupy the

Digitized by Google

same palæontological zones. 2nd, That whilst all such remains of man are exclusively of the American Indian type, the monkeys called *Hapale*, *Cebus*, *Callithrix*, etc., are equally 'terræ geniti' of this continent. . . Finally, that *permanence of type*, as well for humanity as for simiadæ, is firmly established in both genera, from the hour in which we are living, back to a vastly remote, if not incalculable, era of unrecorded time." To the evolutionist of our own day, the very result of such reasoning is to lead to ideas of unity of origin vastly more comprehensive than that which, within a period so very recent, was thus rejected as wholly incompatible with deductions from much industriously accumulated evidence.

It is curious, indeed, to endeavor now to realize to ourselves what distinct idea was present in the mind of Agassiz when he apportioned his essentially diverse types of man to their specific "natural provinces;" or what Dr. Morton conceived in his own mind when, after affirming one of the three propositions which he believed himself to have established, to be "that the American nations, excepting the polar tribes, are of one race and one species, but of two great families, which resemble each other in physical, but differ in intellectual character:" he fancied that any difficulty, arising from such physical diversities as it was impossible for even him entirely to ignore, could be removed by advancing the hypothesis, that "these races originated in *nations*, and not in a single pair; thus forming proximate but not identical species." The only thing which is at all clear is the assumption of what may be called a gregarious creation: the summoning into existence, by some unknown process, or creative fiat, of an entire race, or nation, at the first peopling of this New World with its own specific aborigines, "essentially different from the rest of mankind."

But Malte Brun and Robertson, Humboldt, Morton, Meigs, Gliddon and Agassiz, all concur in excepting the polar tribes, or Eskimo, from the assumed American race peculiar to this continent. Latham says of the Eskimo: "physically he is a Mongol and Asiatic; philologically he is American, at least in respect to the principles upon which his speech is constructed." But whencesoever we may derive them, they too are ancient and widely scattered occupants of the strange inhospitable region appropriated to themselves. One branch of them, the Labrador Eskimo, borders on our own Eastern settlements on the St. Lawrence: beyond these are the East and the West Greenlanders, including the natives of

Digitized by Google

the Danish trading settlements. To the north of them are the Eskimo of the west coast, north of Melville Bay, styled, by Sir John Ross, the "Arctic Highlanders." But their extreme northern limits have yet to be determined. The most advanced arctic explorers have either come in contact with the natives, or found traces of their habitation; and their habits and indifference to the extremest rigor of the climate, justify the assumption that only the absence of game will restrict the limits of their habitat. They occupy the whole coast regions of Behring Strait; and extend beyond that to the islands and neighboring continent, westward even to the shores of northeastern Siberia. The collection formed by Professor Nordenskeold in his Vega expedition — part of which was exhibited at Edinburgh during the present year,— includes an interesting series of implements used by the Chukches of Siberia and the Asiatic Eskimo in fishing and hunting. They employ the same kind of harpoon for hunting the walrus; use a long spear of nearly the same fashion, generally furnished now with an iron head, for hunting the bear; while their arrows are still pointed with walrus ivory. Such traces alike of community of arts and of race, within the arctic circle of the Asiatic and American continents, and even extending to Europe, show that, whatever may have been the ancient lines of migration, the overflow in later centuries across Behring Strait has been from the American continent westward into the Old World.

This widely scattered race, though corresponding in ethnical character, is broken up, by the exigencies of their rigorous climate into small tribes and isolated bands, dispersed for the most part over a coast line extending from Labrador to Behring Strait upward of 5,000 miles, and migrating with the animals on which they depend for subsistence. They are hunters and fishers. The deer, the polar bear, the wild goose, swan, and other birds that resort to arctic breeding grounds, are alike objects of the chase; but they primarily depend on seals and cetaceous animals, the blubber of which furnishes food calculated to beget the animal heat which enables them to brave the severity of an arctic climate. *Eskimántzik* appears to be an Abenaki term signifying "eaters of raw flesh;" and as such indicates the surprise with which even the Indian nomads of New England viewed the strange habits of the hyperborean hunters with whom they were occasionally brought into contact. The Eskimo, however, is neither ignor-

Digitized by Google

ant of the use of fire, so indispensable to him in his rigorous climate; nor is he an exception to the fitting definition of man as "the Cooking Animal;" though in his peculiar condition of exposure to an arctic winter, raw blubber is at once a necessity and a luxury.

In one respect, as already indicated, the Eskimo occupy a peculiar position on this continent. They are the only race common to the Old and the New World; and, if we accept the conclusion arrived at by the author of "Early Man in Britain," they constituted an Old World race to all appearance before this New World had come into existence. The cave men of Europe's palæolithic era, the contemporaries of the mammoth, and other long-extinct mammals of central Europe, have naturally excited an unwonted interest, as their arts and their remains have been brought to light in recent years. A people of lowest type, as illustrated by the famous Neanderthal skull, that of the Forbes quarry near Gibraltar, and of the Gourdon grotto, with some imperfect traces of others, all classed under the common term of "The Canstadt race," is now assumed to represent the earliest, if not indeed the primæval man of ancient Europe. So far as rudest flint implements afford any evidence of his condition, we might class him with the Bosjesman, the Australian, or the Patagonian of our own day. The evidence, however, in proof of the existence of this Canstadt savage race of palæolithic Europe, rests as yet on insufficient grounds. Curiously, indeed, Professor De Quatrefages has drawn attention to the fact that not only are heads of the Neanderthal type to be met with in modern Europe, in some examples pertaining to men of exceptional intelligence; but the skull of Saint Mansuy, Bishop of Toul, of the fourth century, surpasses the Neanderthal cranium in some of its most simian features; and that of the sagacious and politic hero of Scottish independence, Robert the Bruce, "is a reproduction of the Canstadt type."

But however uncertain our conclusions may as yet be relative to this assumed primæval European type, there is no doubt as to the Cro-magnon race of the reindeer period of southern France. Examples have, indeed, by no means been confined to that area. The Enghis skull was found, with other human remains, embedded in a breccia along with teeth of the fossil mammoth, rhinoceros, horse, and reindeer, in a cavern on the left bank of the Meuse; and the Mentone cave, to the south of the Alps, disclosed an undisturbed sepulchre of the same ancient hunter race. But a

Digitized by Google

special interest attaches to the remains brought to light in 1858, in the rock shelter of Cro-magnon, in the valley of the Véserè. Three men, a woman and a child, had all been buried in the cave. From their remains it is seen that the race was unusually tall, and bore equally little resemblance to the Neanderthal or "Canstadt" type, or to the modern Eskimo. The best preserved skulls—those of an old man and a woman,—are finely proportioned, with large, high foreheads, and great cerebral capacity. M. Broca stated that of the man to be fully 1590 cubic centimetres, or 96.99 cubic inches; and Dr. Pruner-Bey says of two of the male skulls and that of the female, they "have a cranial capacity much superior to the average of the present day." It may remind us of Mr. Alfred Russel Wallace's remark that "natural selection could only have endowed savage man with a brain a little superior to that of an ape, whereas he actually possesses one very little inferior to that of a philosopher."

Whatever differences of opinion affect the determination of the probable age of the Cro-magnon race, they unquestionably pertain to a period so remote that the very earliest historical traces of man in southern France scarcely seem to bring us any nearer to the period which they represent. Their physical characteristics have, therefore, a special significance. The skulls are dolichocephalic, with the frontal bone high and well arched, a graceful fronto-occipital curve, and well-balanced symmetrical proportion throughout. The profile of the old man indicates an expressive contour, the face long, the nose very prominent, and the frontal sinuses but slightly developed for a male. The full face presents a well-proportioned oval, with pointed chin. The one feature detracting from its otherwise attractive expression would seem to have been the unique character of the long and narrow eyes, as indicated by the unusual form of the orbits. At the same time it is to be noted that this well proportioned head bears ample evidence of the exposed life of the wild hunter. The features are rugged, as of one subject, through a long life, to all the hardships of a rigorous climate; and numerous strongly marked impressions of muscular insertions accord with the conditions of savage life.

This is the type of an altogether remarkable prehistoric people, the artistic race of the palæolithic era, to whose skill we owe the contemporary etchings and carvings of the mammoth, the fossil horse, the reindeer, and other mammals of that strangely remote

Digitized by Google

era, when the conditions of life in southern France most nearly resembled those of Rupert's Land or Labrador at the present day. Some of their artistic efforts embrace vegetable as well as animal life; and in their graphic outlines, there is a freedom of handling, an eye for perspective, and even what may truly be called an inventive skill, altogether remarkable in a people ignorant of metallurgy, and living in the condition of rudest hunter life.

Such are the characteristics of the cave men recovered from the rock-shelter of Cro-magnon, in the valley of the Vésère, lying above the long accumulated debris which proved the palæolithic era of its occupants. These ancient hunters of the Garonne and the Pyrenees, the contemporaries of the mammoth and other extinct mammals, and of the grizly bear, musk-sheep, reindeer, and other species now existing only in extreme northern latitudes, had occupied the cave throughout a prolonged period. The charcoal deposits prove the kindling of their fires through long series of years; with recurring intervals of considerable duration. Intermingled with, and overlying, the beds of charcoal, are flint implements, broken bones, and the like debris of a savage hunter's dwelling: in this respect presenting considerable resemblance to the site of an Eskimo settlement. Those accumulations went on until the cave was filled up so nearly to the roof that the hunter could no longer even crawl into it for shelter; and then it was devoted to its final use as a place of sepulture. Had the human remains recovered under such circumstances been characterized by extreme development of the superciliary ridges, a low, narrow, retreating forehead, and other brutish characteristics assigned to the "Canstadt race," there would probably have been no questioning the assumption that in them we have the type of the earlier Palæolithic occupants of the cave: the artistic hunters, to whose skill we owe the spirited life-sketch of the mammoth found in the neighboring La-Madelaine Cave, engraved on a plate of mammoth ivory. But the hypothesis adopted by Professor Boyd Dawkins that the clew to the ethnology of the palæolithic race of the Caves is recovered by the identification of the ancient tool-makers with the Eskimo, could only be maintained by assigning the human remains to a later age than the underlying debris. He accordingly rejects the opinion, so consistent with the general evidence which has satisfied M. M. Lartet, Hamy, De Quatrefages, and other equally qualified judges, that in the old man of Cro-magnon we

Digitized by Google

have the type of the palæolithic race contemporary with the mammoth: the artistic sculptors and draftsmen of that remote European era.

In discussing the fascinating idea which would recover, in the hyperboreans of our own northern frontiers, the men of the same migratory race that, before the close of the pleistocene age, followed the musk-sheep and the reindeer into their northern haunts, Professor Dawkins reviews the manners and habits of the Eskimo, a race of hunters, fishers, and fowlers, accumulating round their dwellings vast refuse heaps similar to those of the cave-men of ancient Europe. The implements and weapons of both do indeed prove that their manner of life was the same; and as he notes the use at times by the Eskimo of fossil mammoth ivory for the handles of their stone scrapers, he adds: "it is very possible that this habit of the Eskimos may have been handed down from the late pleistocene times." But what strikes him as "the most astonishing bond of union between the cave-men and the Eskimos is the art of representing animals;" and after noting those familiar to both, along with the correspondence in their weapons, and habits as hunters, he says: "all these points of connection between the cave-men and the Eskimos can, in my opinion, be explained only on the hypothesis that they belong to the same race."

The hypothesis is a bold one which would thus assign to the rude arctic hunters of this continent a pedigree and lineage compared with which that of the Pharaohs is but of yesterday. To the geologist who fully realizes all that is implied in the slow retreat of the palæolithic race of the valley of the Vésère over submerging continents since ingulfed in the Atlantic, and through changing glacial and sub-glacial ages, to their latest home on the verge of the pole, the time may suffice for any amount of change in the physical characteristics of the race. But if these have vanished how is the lineal descendant of the palæolithic cave-men to be identified? Not by mere imitative art; for that is common to many widely dissimilar races of the American continent. Professor Dawkins says truly of the cave-man, "he possessed a singular talent for representing the animals he hunted; and his sketches reveal to us that he had a capacity for seeing the beauty and grace of natural form not much inferior to that which is the result of long-continued civilization in ourselves, and very much higher than that of his successors in Europe in the Neolithic age. The hunter

Digitized by Google

who was both artist and sculptor, who reproduced with his imperfect means at one time foliage, at another the quiet repose of a reindeer feeding, has left behind the proof of a decided advance in culture, such as might be expected to result from the long continuance of man on the earth in the hunter state of civilization." All this is correct in reference to the art of the Cro-magnon carvers and engravers, and seems in full accordance with the fine heads and great cerebral development of the ancient race; but it would be gross exaggeration if applied to such conventional art as the Eskimo arrow-straightener which Professor Dawkins figures, with its formal row of reindeer and their grotesque accessories. The same criticism is equally applicable to numerous other specimens of Eskimo art, and to similar Innuit, or western Eskimo representations of hunting scenes, such as those figured by our associate Mr. William H. Dall, in his "Alaska," which he describes as "drawings analogous to those discovered in France in the caves of Dordogne."

The imitative faculty and artistic skill of the old Mound-builder race are very familiar to us; and have furnished valuable evidence of a knowledge by them of a tropical fauna, including animals of the southern continent, suggestive of the probable direction of their own migrations, and their consequent affinity to southern races. Within our own Canadian Dominion the arts of the Queen Charlotte islanders are no less worthy of note. Their curiously conventional style is shown alike in their idols, or manitous, elaborately carved in black argillaceous stone, and in the corresponding decorations of their lodges. In front of each Haida dwelling stands an ornamented column formed in many cases of the trunk of a tree large enough to admit of the doorway being cut through its substance. This column, or obelisk, is carved throughout its whole length in their peculiar conventional style of ornamentation, suggestive at times of affinities to Peruvian sculpture; or, again, of borrowed art of possible Japanese origin. But already the imitative faculty of the Haida artist leads him to revert to European models; his traditional patterns and devices will speedily be among the lost arts of this continent, and the race itself, it is to be feared, is doomed to speedy extinction. All the more urgent is it that no time shall be lost in the accumulation of every available fact, and illustrative specimen of their curious art. Already a valuable contribution to this has been furnished in

Digitized by Google

Dr. George M. Dawson's "Report on the Queen Charlotte Islands," published as one of the Reports of the Geological Survey of Canada.

The Tawatin Indians on the Fraser River work with no less ingenious skill, and in a like style of combined imitative and conventional art, suggestive at times of curious analogies to some of the finished sculptures of Yucatan. Some of their ivory carvings are executed with a minute delicacy of workmanship such as no Eskimo carver could surpass; but with the same kind of conventional ornamentation as is in use by the Haida artists, strongly suggestive of inherited modes of thought, and traces of intercourse or relationship with the ancient civilized races of Central America.

There is thus no need to assume for the imitative arts of the New World a European source in the remote dawn of pleistocene times. Nor is the identity discernible between certain harpoons and other implements of the ancient hunters of Central Europe and those of the arctic Americans of our own day much more demonstrative of derived arts or community of race. Within the comparatively narrow range of needful weapons or implements, the correspondence notable between some of those of the palæolithic cave-men and of the Eskimo amounts to little more than what is seen in flint arrowheads, stone hammers, and the more common primitive tools of all kinds, executed under nearly similar conditions of life. "The absence of pottery" proves little more than the absence of tropical vegetation; for both were nearly equally impossible under the conditions of climate. The preference for bone and ivory as the materials for their arts is equally due to climatic conditions which render rock and flint generally inaccessible throughout the greater part of the year. The points of agreement are, in truth, little more than are to be anticipated among savage tribes living under similar conditions of climate.

If, however, the skulls of the Cro-magnon cave-men resembled those of the Eskimo, or the underlying debris revealed any traces of crania of the Eskimo type, there would then be good reason for giving consideration to the bearing of any supplementary evidence depending on correspondence in arts, usages and habits. But neither the Cro-magnon cave, nor any other of the caverns of the district, otherwise so rich in archæological and palæontological traces, has yielded the needful evidence. The contrast between the large, well developed Cro-magnon race and the stunted,

Digitized by Google

almost dwarfish Eskimo at once attracts attention. But much greater difference in stature would find ready solution in the privations of an arctic habitat prolonged through unnumbered ages. The notable fact, however, is the absolute contrast in every respect. The Eskimo physiognomy is of a poor Mongolian type. The nose is flat, and the cheek bones are very prominent; the tendency in the skull is towards an acrocephalic form, narrow and long, with the parietal bones frequently meeting at an angle at the sagittal suture. The one possible point of resemblance that could be suggested with any acceptance would be the eye, which in the Eskimo seems often narrow and oblique. This, however, may be apparent only, traceable to the habits of a people one-half of whose year is an unbroken midnight; and who grope in the darkness of their obscurely lighted snowhuts. Certain it is that the long, narrow orbits of the Cro-magnon skulls are not represented in the modern crania.

Sufficiently extensive opportunities of studying the Eskimo cranium have come within my reach to afford me some fair means of forming an idea of the predominant type. In 1862, through the kind services of the late Dr. J. Aitken Meigs, I enjoyed the advantage of carefully examining a series of one hundred and twenty-five skulls, obtained by Dr. Hayes during his Arctic explorations, and making drawings of some of the most marked examples. I have also examined and taken careful measurements of other examples including Western Eskimo, Innuit, and Tschuktchi crania, in the collections at Washington. With the resulting impressions in mind, it is impossible to look on casts of the large and finely developed Cro-magnon skulls now in my possession without being struck with the extreme contrast between them and the Eskimo crania. No wonder that they prove a stumbling block to evolutionists, who look for something of a totally opposite character in the Troglodytes of the palæolithic, or pleistocene age. M. M. Lartet, Hamy, De Quatrefages, the editors of the *Reliquiæ Aquitanicæ*, and other equally competent authorities, have had no difficulty in accepting the evidence that the reindeer hunters of the Vésère lay there intombed in the cave which had so long been a shelter to men of the same race. Had the Neanderthal skull been found under similar circumstances, no doubt, founded on its lower cerebral capacity, would have interfered to prevent its recognition as the type of the artist race to which we owe the life-picture of the mammoth. But Professor Dawkins not only notes that the human

Digitized by Google

remains were deposited in an abandoned palæolithic cave, when it had been nearly filled up with the accumulated debris of successive occupants; but he assigns the remains to the later Neolithic age, notwithstanding the absence of any accompanying relics of the art of the polished stone period.

But I have already exceeded the reasonable limits of an address to this Section of Anthropology, and must leave unnoticed various further points in reference to the aborigines of the Dominion, illustrative alike of the physical characteristics of our native Canadian tribes, and of some special points of significance in relation to their arts. One deduction, however, may be worthy of future consideration. If it be a fact borne out by much independent evidence, that from the extremest northern range of the arctic Eskimo, southward to the Great Lakes, and beyond this, especially to the east of the Alleghany Mountains, amid considerable diversity of ethnical characteristics, the dolichocephalic type of head prevailed; whereas among more southern tribes, such as the Osages, Ottoes, Missouris, Dacotas, Cherokees, Seminoles, Creeks, and many others, including the Florida Indians, the short, rounded, or brachycephalic head appears to have been universal: this seems to point to a convergence of two distinct ethnical lines of migration from opposite centres. In this, as I believe, the evidence thus derived from physical characteristics confirms what is indicated by wholly independent evidence of language, traditional customs, and native arts.

Digitized by Google

PAPERS READ.

Notes on Mount Atlas and its Traditions. By R. G. Halfburton, of Ottawa, Canada.

[ABSTRACT.]

In Dec., 1881, to while away the time at Tangier, where continuous east winds for weeks kept invalids within doors, I turned my attention to the traditions and folklore of the natives of Marocco. The field was represented as a barren one. I was told that the country was inhabited mainly by the Berbers (or Barbars, whence the name Barbary); that, though composed of different tribes, they spoke substantially the same language; and that having adopted the religion of Islam, they had forgotten their old traditions and superstitions. The Riffians, known still in history as the Riff pirates, inhabit the northern portions of Mount Atlas. To the south of that mountain is a tribe of excellent artificers in brass and copper, called Shelluhs, Shilhas or Silhachs, who inhabit the province of Sūs, and are therefore called Susis. There are other tribes still farther south.

It soon leaked out that the faith of Islam sits very lightly on some of the Susis, and that many of them really have no religion, or have some ancient superstitions which they preserve in secret. Whether they really believe the myths and traditions which they repeated to me, or merely regard them as our peasants do their fairy tales and folklore, it is hard to decide. One of them told me he was not sure that he was not as much of a Christian as of a Mohammedan — a statement that if overheard by the Moors might have cost him his life.

I made careful inquiries from several Riffians, a Maltese who had travelled in the interior of Africa, disguised as a Moor, the town time-keeper or astronomer at Tangier, some Jews of Casablanca and Ophran, two Susis at Tangier, and one at Mogador, nearly all of whom, though illiterate, and unable to read Arabic, were learned in oral tradition and Berber folklore.

Digitized by Google

The results of my inquiries proved that there is a marvellous collection of ancient myths, legends, etc., among the Susis, which carry us in succession to Britain, Greece and Rome, Phœnicia and Egypt, and even to Babylon, while one very remarkable festival seems as if it had reached them from the Aztecs.

The Great Mother of the Greeks, Damater, appeared as *Ta Mata*, "the mother, who presides over the corn fields." Apălo, "a good god who comes and plays on a harp," suggests the inquiry, is not Apălo the original form of the name of the god Apollo?

At certain intervals, as the Greeks believed, Apollo used to desert his shrines, and go far off to the blessed Hyperboreans, with whom he danced and sang until the rising of the Pleiades.

The ancient Greeks themselves seem to have regarded the Atlas country as the favorite abode of Apollo. Atlas was a Hyperborean, and the western Ethiopians, who inhabited that country, were also Hyperboreans, a semi-divine race, from whom the Greeks derived many of their most ancient rites. It is supposed that they were called Hyperboreans from their enjoying a climate where the cold north wind was unknown, but the same name would be even more applicable to the people of the interior of Africa. I am inclined to think that it meant "those who dwell beyond Borium," a very ancient town on the borders of Mauritania, to which I shall hereafter refer.

A Susi described to me a staff ornamented with ribbons, which is called a *thurosis!* The names too of Mata, Kĕra and Zerēa, recall that of Ceres. The "Great Mother's" image is bathed at the end of her festival, as it was in the holy island of the Germans, at the river Almon, and in Athens at a feast of Minerva, which was therefore called *Plynteria*. We are even reminded of a similar rite at the end of the feast of the god of agriculture of the Fijians.

The god Adon is still believed to have been slain by a boar, and heaven and earth all weep for him. "He was greatly beloved by Tachal and Isai." It seems that some *festive dirges*, like the Maneros of the Egyptians, and the Linus of the Greeks, which were sung at their banquets, can still be traced in the *Accasili Maneros* and the *Wălĭnas* of the Susis. Diodorus Siculus tells us that in the Atlas country a divine youth, Hesperus, went up at night to the summit of a mountain to study the stars, and a great wind carried him away. To this day (I am told by the Susis) "the women go up on the mountains with music, weeping, in their search

Digitized by Google

for Walinas. He was the brother of Panis, an old god who invented pipes called Kraf or Kalifer, and who was also called Itada."

One of the Susis asked me if I would like to hear "the story of the man who wished to steal the cows," and upon being asked to proceed, retailed a familiar bit of classical mythology: "There is a great mountain in the sea, where there were 300 cows the property of Geryon, and when the sun set they used to appear. It was a very rich place, and a navigator, who wished to steal the cows, sailed thither, and entered a great cave, from which he never came out; and his name was Herakles."

There can be no question that this mountain, the true Mount Atlas, was the Peak of Teneriffe, in which there is a vast cave that has never been fully explored. The Atlas country was the scene of the labors of Hercules, and of the feats of Perseus, who turned Atlas into a mountain by showing him the Gorgon's head.

Herodotus says that the dress of the statue of Minerva was borrowed from the Atlas country, where clothes of kid-skin are made and colored with great skill. Such dresses may still be seen in the Museum of Las Palmas, taken from the mummy caves of the Guanches. He also suggests that the story of the head of Medusa being encircled with snakes, arose from the head having been placed on a shield ornamented by the Atlantes with a fringe consisting of long strips of leather, which at a distance might well look like snakes. These fringes are still used by the Susis.

Even the Greeks admitted that one of their most unintelligible myths, that of the fifty daughters of Danaus, who were doomed in Hell to the task of filling sieves with water, came from Africa, and they therefore gave the brother of the Danaides the name of Ægyptus, though modern Egyptologists have failed to meet with the myth in the religion of the ancient Egyptians. Many years ago a devout believer in "Arkite lore" detected an allusion to the deluge in the name of Danaus, which he traced to *dan*, "water" or "rain." If he had called the fable a "rain myth," he would perhaps have been nearer the mark. It was evidently carried by the natives of the Atlas to Greece, where in time its original meaning was forgotten, for we still find it in the folklore of the Susis, one of whom told me that "there is an old King in the stars of rain, who has many dancing women, who hold sieves filled with water; and when he wishes them to dance, he thunders. The louder grow the peals, the quicker and wilder grows the dance,

Digitized by Google

during which the sieves are emptied, and the water falls to the earth in a thunder shower."

These are a few only of the traditions and beliefs that carry us to Greece and Rome. We meet with Phœnician traditions also as to "Isiri who taught the three letters;" while the belief in an imperfect creation, in which the forms of animals and men were blended together, recalls a similar tradition of the old Chaldæans. Of Egyptian ideas there are perhaps traces in a belief as to seven brothers who sail in their ship across the sky, and carry with them the spirits of the dead.

The Susis have a May day festival at which the "pole of Maia" is set up, at the summit of which is a doll composed of heads of wheat. Saints climb up the tree and scatter the wheat among the people, calling it "our life," "our sustenance." The Mexicans used to erect an enormous cross, the symbol of rain, and on its summit was placed a similar doll, which when reached by those climbing the pole, was scattered among the people, who treasured the fragments as something sacred, while the deity represented was called "our life," "our support." The coincidence is certainly very remarkable, for precisely the same words were addressed by the Iroquois to the three beneficent maidens residing in the Pleiades, who brought each her gift to mortals, the maize, the squash, and the bean.

Herodotus has mentioned that the peculiar cry of the women at the rites of Minerva, called *ololuzein*, was borrowed from the Libyan women, "who sing it very sweetly." I have heard this peculiar chorus or cry which consists of a quick repetition of the word ălō,— ălō ălō ălō ălō. I am told that it is raised at the end of the feast of Mata when water is poured over the image of the goddess; and am reminded of the shout that resounded throughout Fiji at the close of the feast of Ratimaimbulu, who no doubt was the same as the god Alo-ălo of the adjacent Friendly or Tonga Islands. It would be exceedingly interesting if it should prove that the cry raised and carried from town to town in Fiji was, like that at the feast of Mata, *ălo ălo ălo ălo*.

If there is any foundation for the belief of the earliest nations and of the Susis themselves, that that country was once the seat of an ancient civilization, how can we account for the early rise of a great commercial and maritime people near Mount Atlas? The answer may be given in one word—*gold*. One of the natives examined at Mogador was Mordecai Rhibo, a Jew from Ophran, which he de-

Digitized by Google

scribed as a very ancient town, which from remote ages has been the entrepôt of the Timbuctoo gold trade. At that point the caravans separate and go in different directions, one to the city of Marocco, and the other beyond Tripoli.

There are Jewish tombstones there dating back nearly to the beginning of our era. There is also a vague tradition that there is somewhere in the interior a tribe of Jews who are warlike and independent, and who have no knowledge of the Second Temple.

I ventured to suggest, when I read my paper, that we have good reason to believe that the *Ophir* of the Bible, and *Saba* or *Sheba* may yet be traced to that part of Africa. This has since been confirmed by my finding in Procopius, that one of the two great divisions of Mauritania was called *Zaba*. He also states that there was in his day (*circ.* A. D. 550) a very ancient city in Numidia, on the borders of Mauritania, called *Borium*, which from the most remote times had been inhabited by Jews, who had never paid tribute to any one. There was there too a very remarkable Jewish temple, which the Jews believed had been built by King Solomon. As the adjoining country was called *Zaba*, and as no trace of the first temple has ever been found in Jerusalem, it is not impossible that this was the temple to which the Queen of Sheba paid her famous visit.

It is probable that nomad Berbers, known as Sabæans, had, in the days of Abraham, as they still have, the monopoly of the gold and ivory trade of central Africa, and with their caravans carried its products, including slaves, parrots and incense, to central Asia. The Sabæans were, like the Susis, astrologers, necromancers, traders and robbers, believing in the seven heavens, and worshipping the seven stars. It has been conjectured that in the Puranas, traditions of an earthly paradise, differing from that of the general Hindoo system, seem to point to Africa (see Smith's Dictionary of Bible, *tit.* "Eden"). But the place to which we must turn cannot be, as Smith's article suggests, in southern Africa, but rather in northwestern Africa, where the garden of the Hesperides and the Islands of the Blessed were situated.

The Susis have a belief in seven heavens called *Saba Samagwats*. *Saba* means seven; the other word, by the aid of a pre-Malayan language in Malacca, can be interpreted, as it is the same as *samangats*, "the spirits of the Blessed," who reside in Pulo Bua, "the fruitful island in the west." I have also been shown

Digitized by Google

a diagram of the mystic ladder for the descent and ascent of souls, called *Azacol*, representing "the path of the spirits" (*Azero*). It is like the ladder with seven lamps that typified the seven "houses" or "gates of heaven" in the rites of Mithra. These Susis are necromancers and astrologers, resembling the gipsies in looks, habits and ideas. One of them at the outset offered to bring up any spirit that I might wish to do my bidding,—an offer that recalled the question of the Witch of Endor, "And the woman said, whom shall I bring up unto thee?"

To show how indestructible the peculiar traditions of these people are, I may mention that a Susi told me gravely of a remarkable race at the river Byblah (Byblus?) "which is near the centre of the world somewhere between us and the Soudan," who have the faces of dogs. Herodotus, 2,500 years ago, was told precisely the same story, a belief in which, among the Egyptians, can be traced in their mystic *cynocephali*.

It may seem premature to endeavor to account for this strange collection of myths from apparently all parts of the world. A few facts connected with the history of Mount Atlas may be suggestive of interesting inquiries.

The earliest traditions of Greece point to Mount Atlas and to the garden of the Hesperides, which was on the flank of that mountain. The Susis told me that their people is the most ancient in the world. Diodorus Siculus says that the Atlantes claimed to be the most ancient of nations, and that their country was "*the birthplace of all the gods of antiquity.*" Solon was told by the Egyptian priests the same tale, that the Atlantes were the first great commercial and maritime people, and exceeded in wealth all the great nations of later times, and that they extended their conquests as far as Greece; but in consequence of a sudden irruption of the sea, the great island they inhabited was buried under the waves in a single night. History proves too that the Berber race was once dominant over northern Africa, and it is probable that they supplied the Hycsos or Shepherd dynasty that ruled over Egypt for centuries, and who have been connected with the Moors and Berbers by Movers.

One of the names of the Atlantes was *Maxyans*, which is possibly derived from a word in Arabic meaning "sheep." Even Amazighi (one of the numerous forms of their name) may come from *am* "of," and *ashigir*, "a bullock." Atlas, who, as a daring

Digitized by Google

navigator, "knew all the depths of the ocean," and who taught Hercules astronomy, was also called "*a shepherd.*" The Susis (at least the nomad portion of them) are still called by the Arabs *Beni Baccar*, "the sons of the cow," the pastoral people. Even the word "Sos," according to Herodotus, meant, in the sacred language of Egypt, "cattle."

It has been conjectured that the light-haired race, that from the most remote ages occupied the Atlas country, lost their language and adopted the Berber tongue. I have recently found not less than seventy familiar English words in use in Marocco, and it is probable that careful inquiries will show a still larger survival of them in that country.

That Tarshish was a port in the Atlas country seems exceedingly probable. It is admitted that it was situated either in Spain or somewhere on the Atlantic seaboard. It was apparently the Birmingham of early ages, for its brazen dishes were an extensive article of export even to Phœnicia. We have now no trace of such an industry in Spain, but we have the clearest evidence that from the most remote times it flourished in Sus, the people of which seem to be a survival from the Bronze Age, for their principal trade is the manufacture of brass dishes, which they chase with marvellous taste, and which are perhaps known to us as the "beaten dishes" used in the Temple of Solomon. Leo Africanus says that Ifran was in his time (A. D., 1550) a seat of this industry, from the existence of extensive copper mines near that place. Though it is only known throughout Marocco as *Ephran*, its inhabitants call it *Ophran*, and such is the name given to it in the latest English map of that country.

To the ancient Jews it was probably known as Ophir, that mysterious city which tradition says was the capital of the Sabæans, and connected with Tarshish. That the latter was a port of Ophir or Ophran, and situated on the coast of Sus, seems probable from some curious incidents in the history of Jonah, who instead of going eastward from Jerusalem to Nineveh, went to the remotest west, in a ship bound to Tarshish.

To my surprise one day, a Susi told me that a great prophet was swallowed by a large fish and cast up by it on the coast of Sus, and I at first assumed that he had picked up this story from some Jew; but I have since discovered that it is an ancient local tradition as to Hercules, the hero of the Atlas, who must have sailed

Digitized by Google

from a port in western Marocco, for on ancient maps we find a harbor there called "the port of Hercules." The two stories (whichever may have been the original one) point to a tradition connected with the Atlantic and the coast of Sus.

Many myths have a local origin in some natural phenomenon that primitive races cannot explain, except by the supernatural. We may find the key to this venerable tradition of antiquity as to Hercules in the existence, near the place in question, of sharp pointed rocks, which are fatal to whales that may be driven on them by a storm. Hercules, we are told (see Took's Pantheon, Part II, ch. 1; Ovid Met., II) "delivered Hesione, the daughter of Laomedon, King of Troy, from the whale in this manner; he raised, on a sudden, a bank in the place where Hesione was to be devoured, and stood armed before it; and when the whale came seeking his prey, Hercules leaped into his mouth, slided down his throat, destroyed him, and came away safe."

The tradition, which I had heard from a Susi, also existed in the days of Leo Africanus, who tells us that in the town of Messa, the name of which means "Lord," and at which the natives believe that the promised Messiah will appear, is a very ancient and sacred temple, the rafters of which all consist of the bones of whales, in commemoration of Jonah having been cast up by a whale on the adjacent seashore; and that in confirmation of this belief, the Moors pointed to the fact that all the whales immediately die that pass to the right of the temple. The historian was inclined to think that there might be something in the story, from his seeing at the time a dead whale floating near; but a Jew ridiculed the superstition of the Moors, and explained the origin of it, by the existence and effects of the reef in question,—that bank, no doubt, that Hercules raised suddenly for the destruction of the whale. I think there can be little question that this ancient whalebone temple of Jonah was originally built in honor of Hercules, the hero of the Atlas country; and it is possible that the story connected with it may have been carried back to Palestine by the Jews of Ophir, and have been preserved by them in the history of the prophet Jonah.

May not they also have brought back from Ophir the Book of Job? That work is a singularly faithful picture of the productions, animals, traditions, manners and astronomical ideas that are still to be found south of Mount Atlas. There to this day wan-

Digitized by Google

dering bands from the desert sweep down upon the herdsman and the shepherd, and rob them of their herds and flocks; and the ostrich, the hippopotamus, the monsters of the ocean, the birds, the beasts, the treasures of the mine, and the stars, that are described by the patriarch, are still familiar to its inhabitants. Even that auspicious constellation whose "sweet influences" are celebrated by him, is known by the same name to the Susis, who call it *Kimah* ("a furrow"), or "the stars of tillage" as it is termed by the far distant Bechuanas of south Africa (*Silemela*).

The people of Sus also believe that there is a certain night in the year when the stars hold a solemn festival, in which all the angels and the spirits of the great kings of old take part. The very words of the song of the Pleiades, who are known in the New World as well as in the Old, as "the dancers," "the Celestial chorus" of the Greeks, "the Heavenly Host" of the Hebrews, and "the seven dancers" of the North American Indians, are familiar to ears that can catch "the music of the spheres," and have been repeated to me by one of those favored mortals, a Susi wanderer from the Sahara:

> "Oh Moon, oh Mother, we hold our feast to-night,
> We are dancing before God, between heaven and earth,"

words that recall Milton's allusion to those "morning stars that sang together with joy" at the creation,

> "And the Pleiades before him danced,
> Shedding sweet influences."

This celestial festival evidently takes place on that night in November, when the full moon and the Pleiades are on the meridian together, for there is a Susi love song,

> "Oh come to me my love, and long remain,
> For the Pleiades are meeting the moon to-night."

On that very night in November some tribes of the Australians still celebrate "the sweet influences of the Pleiades," and hold a grand corroboree in their honor, for "they are the children of the Sun and Moon," and "are very good to the blackfellows."

Even the early Egyptians seem to have borrowed many of their religious ideas from an older civilization in the Atlas country, for it has been conjectured that all the magical features of the ritual

Digitized by Google

of the Egyptians, and their belief as to the dangers attending the passage of the soul to Hades, were derived from the people south of the Atlas (see Smith's Dict. of the Bible, *tit.*, "magic").

It is surprising to find that a country, venerated in the days of Homer, as peopled by "the just Ethiopians" who were nearer to the gods than other men, and at whose banquets even Jupiter was sometimes a guest, a country, too, associated with paradise and the abodes of the blessed, should, a few hundred years after his time, have been lost sight of by the world. Herodotus does not refer to its past history, and learned little of the country south of the Atlas. Strabo says that in his time it was a *terra incognita*, for armies and even travellers had seldom reached it, and the few natives that visited Greece either invented fables about it, or were unwilling to tell what they knew about it. To this day it is closed against Europeans, none being able to visit it except by the hazardous experiment of passing for a Moor.

Leo Africanus, however, himself a Moor, who has described that country as it appeared in his day, and has told us how the Arabs had ravaged it, destroying the cities, and burning the ancient books of the Berbers, states that near the walls of one town, the stones of which, as large as those employed in the construction of the Coliseum at Rome, had defied the fury of the invaders, gold and silver medals are to be found, with characters which he had in vain endeavored to decipher; and that everything indicates that at a former period these cities must have been the homes of a prosperous people.

This paper is the first attempt that has been made to draw attention to the traditions of a country that must once have played an important rôle in history. It is possible that future and more careful inquiries as to it may throw much light on the commerce, and perhaps on the origin of the Jews, and on many obscure points connected with early civilizations and mythologies; and that they may even justify the belief of the Susis that they are descended from the most ancient nation in the world, and the boast of the old Atlantes, that their land was "the birthplace of all the Gods of antiquity."

I intend, if my health permits me, to revisit that country, and to follow up these researches.

Digitized by Google

SOME HITHERTO UNNOTICED AFFINITIES BETWEEN ANCIENT CUSTOMS IN AMERICA AND THE OTHER CONTINENTS. By J. H. PHENÉ, of London, England.

[ABSTRACT.]

THE author of this paper explained that as one of the great problems to be worked out, or which at least it is desired should be worked out by all who have given any attention to the subject, is that of the races and civilizations which once flourished at the southern end of North America, and which had evident connections with the more northern parts of what are now the United States, through those great ducts, the Mississippi and other vast river valleys, tending to the latter direction.

The customs which are shown to have existed in the great river valleys of America, though read with difficulty by the light of the strange monuments still existing there, seemed to the author to have had parallel existences on the other continents. In evidence of this he gave illustrations, by drawings and diagrams, of many earthworks and stone constructions which had been examined by him, and which agreed in the method of executing the earthworks, of arranging the plans and designs, and in the evidently similar purposes for which they were designed, and to which they had been devoted.

The points on which he rested his argument for the affinity of the American mounds and earthworks, and, necessarily, the customs with which they were connected, with those of Great Britain and a large number of similar works in France, Spain, Greece, Asia Minor, Persia and China, were, in the first instance, the existence of relationship to each other, always in the vicinity of rivers, of mounds representing animal forms, and—with some special exceptions—the close proximity of vast works of camps for defence, huge enclosures or oppida for civil occupation, and other evidently sacred enclosures for solemn rites, worship and sepulture. In America these evidences went no farther, but in the vicinity of the mounds he had traced in Western and Eastern Europe, and in Asia Minor, and still farther East, not only were all these features attendant but the localities also abounded with mythological and traditionary legends, and the retention of strange and weird ceremonies to the present day.

He selected as illustrations of the American mounds, those in the forms of serpents, the alligator (or mythical dragon), and the

Digitized by Google

human form. The serpent was shown by Mr. Squire to have been executed in two ways, viz.:—by the solid continuous serpentine form, and by a series of symmetrical mounds uniformly placed in curves. The reader gave examples of each of these, on diagrams, and explained that they existed in large numbers in Great Britain, similar in proportions and construction to those of the American mounds, which were kindred in form, and accompanying these were, he stated, in every case, extensive areas occupied by similar camps and enclosures for civil occupation, or oppida, and also separate enclosures for worship and sepulture. The characteristic physical, natural and art features were also curiously persistent in each case, a triple imagery having been in very many instances studiously represented, both by places of selection, as the vicinity of triple peaked mountains, and in construction, by triangular chambers and triangular enclosures in or about the head of the animal forms, as well in the American as in other similar mounds. Since his arrival at Montreal he had heard of indications of this having been an Indian burying ground. They appeared often to have selected places of previous occupation, as in the mounds; and the triple hill and trianglar piece of land at its base were significant. The works in Great Britain, Spain, France, and other countries, were found to contain chambers filled with cremative matter, and had studied arrangements for preserving the outlines of the animal forms, as shown in the diagrams, and were generally surrounded with vast lithic arrangements, and each, as a rule, was in the centre of an extensive necropolis of the primitive inhabitants. The legends and traditions clustering about these places were always of the same class in the other continents, and almost always had reference to man as the possessor and the serpent or dragon as the persecutor or destroyer, and this whether the tradition was one of uncultured and primitive existence, or of the highest classical art ages and localities; and though such traditions did not exist in America, yet not only did their huge mounds simulate these forms, but there had been dug up from their mounds rude sculptured figures of the human form and also of entwined or coiled serpents, showing that in their construction the same ideas, if not similar legends and traditions, had existed, as those which originated the gigantomaxia of Pergamos.

Amongst other numerous and striking examples of these forms in Great Britain, corresponding with the animal and human forms

Digitized by Google

in America, were some very remarkable and yet but little-known representations of the human form belonging to a rude and unlettered age, perhaps corresponding to that of the semi-barbarous age of Mexico, which are found on the coasts of Devonshire and South Wales sculptured in stone, a very remarkable example of which also existed near West Hoathly, in Sussex, which was traditionally stated to have been worshipped as a potent deity (the goddess Andras) by the early Keltic inhabitants. In the vicinity of these rude figures in the western and eastern extremities of the South of England, were two enormous *intaglio* representations of the human form, corresponding to the *intaglio* forms in Wisconsin, only one of which had been mentioned, and that in a very cursory manner, by writers on the comparison of these works with those of America, while their surroundings had been completely overlooked. The one not referred to was by far the more important, both in size and similarity, being in the exact attitude of the mounds in the human form of the American mound-builders. About midway between these two figures was an equally enormous and well-known representation by *intaglio* of a horse. These figures were all cut in the chalk hills, and might be said to be protecting deities of the three localities in England most abounding in remarkable and vast areas of camps, oppida or settlements, and places of worship. The whole district from Dorsetshire to Land's End being commanded by the gigantic form in Dorsetshire; that of the miles of stone avenues on both sides of the Medway in Kent, terminated by Kit's Coity House at one end, several *alleés couverts* at the other, with the huge stone figure at West Hoathly and the wood of Anderida to the south, were commanded by the similar gigantic *intaglio* figure in Sussex; and the central and more important districts of Stonehenge, with the primitive and stupendous temple of Avebury, its sinuous avenues of stone, and extensive earth embankments, the great tumulus of Silbury Hill, the avenues of stones near Amesbury, in the style of those at Carnac in Brittany, the large number of camps, the trilithon called the "Devil's Den," and the great dolmen known as "Weyland Smith's Cave," appear under the protection of the "White Horse." Metallurgy, a great feature with the mound builders of the Mississippi, was also the peculiar occupation of one, if not of two, of these three districts of southern England and of many of the other localities in which similar works were found in Europe and Asia. And such metallurgy was for all utilitarian purposes con-

Digitized by Google

fined in every such country in which these works exist to the two metals—tin and copper—and analysis showed the proportions in the amalgamation of those metals to have approximated in America, Europe and Asia. The parallelism went further and was continuous in its tract eastward. Brittany, Spain and France on each side of the Pyrenees, and so on to Asia Minor, had the same combined features. In the valley of the Meander in Lydia, the vast figure of "Niobe," mentioned by Homer, still existed, sculptured on the side of Mount Tmolus, and, as well as that of "Sesotris" in an adjacent valley, also so sculptured, overlooked the district in which are the multitudinous tumuli near the Gygean Lake; and the fortifications and camps of the acropolis of Sardis corresponded with those already referred to in position and design; and the same features were found at Ephesus, Smyrna and Pergamos in a striking degree, and extended, as shown by careful drawings and diagrams, onwards eastward as far as China. Considering the skill and thought required to plan such enormous figures with any regard to proportion, and seeing that all the figures had similar accompaniments, the author concluded by observing that they seemed to him to have been the result of a practice and culture transmitted with concurrent customs by way of the Pacific from one continent to another.

THE CROSS AND THE CRUCIFIX. By CHAS. WHITTLESEY, of Cleveland, Ohio.

[ABSTRACT.]

THE purport of this paper was to recommend great caution on the part of archæologists in giving religious significance to letters, symbols or hieroglyphics that may resemble more or less some forms of crosses or quasi-crosses. It was held that the *crucifix* should not be confounded with the cross, which assumes a great variety of forms which were discussed.

The Christian symbol originated at the crucifixion, and had an upright part extending above the arms of the olden cross. In nearly all ancient inscriptions there are letters or symbols that have a greater or less resemblance to the ancient cross. Unless something more is found than a resemblance of form, it is unsafe to draw inferences that they are connected with worship. The Runic characters furnish several that might be called crosses, but which are only letters.

Digitized by Google

Chief Deities in American Religions. By Albert S. Gatschet, of Washington, D. C.

[ABSTRACT.]

The science of comparative mythology is acquainted with the full religious systems of a *few* American religions only; the majority of them are known to us in a very imperfect, fragmentary manner. When we speak of *the religions* of American Indians, this term is not to be understood as bearing chiefly on the moral side of religion, or connecting morals with religious beliefs, as it is done in the monotheistic religions of the eastern hemisphere. With us a religious person is equivalent to a moral, honest person, and God is considered not only as almighty and omniscient, but also as the God of truth, forgiveness, and as the embodiment of moral principles. But rude and savage nations do not connect such ideas with their deities. Their deities represent the objects and powers of nature, as far as these have any influence on the welfare of man. They do not embody originally any moral principle, for the winds, clouds, rains and celestial bodies, which they represent, have nothing moral or immoral in them; they are purely physical objects or powers. To become objects of worship, the forces of nature have to be personified; that is, human souls, passions and powers of reflection have to be imputed to them. Man feels himself in his welfare dependent upon the powers of nature and if he thinks them to be animated with souls and minds like his own, he can at least cherish the hope to communicate with and perhaps to propitiate them in spite of their stern and threatening countenance or their cruel destructiveness. In this early stage of religious feeling men seek to turn the more obnoxious deities in their favor by offerings, sacrifices or ascetic exercises, while the spirits representing the powers of nature favorable to him do not enforce the same attention and are therefore neglected by the ungrateful crowd. This condition of religious ideas necessarily implies *polytheism;* but in adaptation to the objects worshipped by the natives of America, we had better call *polydaimonism* the mode of worship existing in the western hemisphere.

The nations, which by their climatic position are destined to reach a higher stage of culture, will, from the religious condition of polydaimonism, which is an imperfect anthropomorphism, ascend by gradual and easy steps to that of real anthropomorphism.

Digitized by Google

Man being the most perfect being in organic nature, the savage mind naturally regards his nature-spirits as human beings endowed with miraculous powers; or should he continue to see animal monsters in them, he at leasts invests these with human form and garb, arms them with the weapons of man and hears them speaking in the accents of human speech. The more perfectly his nature-spirits become anthropomorphized, in the same degree intellectual and *moral* qualities will be imputed to those regarded as favorable deities, mischievous and immoral characteristics to the obnoxious ones.

After a deity has fully assumed the human shape, it frequently figures as an apparently historical character, as a legislator, ruler in peace, culture-hero, teacher of plastic, fictile and agricultural arts, canalizer of rivers or originator of the calendar. In the tropical regions of America the culture-heroes generally have a duplicate deity of the same origin and representing the same powers of nature, but less approachable and less popular. When this euhemerizing process is completed, miraculous stories decrease in number, while in the earlier stages they made up the bulk of the myths of each spirit-deity. No religion is imaginable without miracles as its base and foundation. Miracles are the childlike efforts of youthful humanity to account for the mysterious working of the natural forces, and owe their origin to the earliest attempts of popular metaphysics and philosophy, of which religion forms a portion.

Ethnology in its present condition cannot assume that there is or was any people on the face of the earth that had no religion in the scientific acceptation of the term. All have some theories to account for the origin of all that exists; all possess definite ideas of the nature of their good and obnoxious gods and of the mode of propitiating or appeasing them, though we Christians prefer to call this superstition, not religion.

The purely physical base upon which the American religions are built up precludes the possibility of anything like our Holy Spirit, the Trinity, hell and heaven or the devil, although early navigators have not failed to discover the latter figure on many of the Indian idols. The Eastern (Asiatic, African) religions present comparatively solid systems when compared with the unsystematic character of the American religious beliefs. Many of the American religions, like those of the Aztecs and Peruvians, are the result of a

Digitized by Google

combination of the beliefs of several nations and therefore necessarily contain contradictions in their myths; but even where the mythology is the product of a single tribe it will show a lack of uniformity. The American deities are but symbols of the objects and powers of nature, as of the winds, the earth, the sky, sun and moon, night and day, the clouds, the rainbow, etc., and the eternal motions, *strifes* and *conflicts* of these reflect themselves in constant contradictions in the myths. The deities of the agricultural nations of the eastern hemisphere have left behind them long ago this early stage, and some of their number have, even in prehistoric times, developed into gods with predominantly mental and moral qualities, because at that early period they had already reached the full anthropomorphic stage. When, finally, by the invention of alphabets the composition of ritual and canonical books of religion had become possible, the beliefs then prevalent were consolidated into dogmatic systems, a powerful priest-class arose to uphold and teach them to the people, and the more highly civilized the nation was, the higher usually was the standard of morals ascribed by the canonical books to their principal deity.

In polytheistic and polydaimonic religions the deified objects and powers of nature are numberless. Objects and phenomena that are of little account to us often strike the imagination of the rude native through some peculiarity, and the result is deification. To every strange object is ascribed a body and a spirit or soul, which can live inside the body and outside of it and is regarded as something supernatural. Prominent deities often receive epithets and when these epithets are no longer understood by the people, because they contain an archaic form of the language, they often become gods or goddesses for themselves independent of the parent deity. Even the emblems of the divinities may become deities for themselves. By such and other causes the number of deities increase, by other causes a diminution is brought about and only the fittest will survive. Some are worshipped only in one province of a country, while others enjoy a more general worship.

In this motley crowd of new and ancient gods a few only rise to general prominence, and among these few one is considered as the principal deity. Many deities are supposed to be antagonists to the rule of this chief god, and though he is the most powerful among the gods, he is not the most popular god amor.g men. Chief deities represent a combination of several powers of nature

Digitized by Google

united in one supernatural being; they are often placed in the background by one or two more brilliant and therefore more popular conceptions of the religious mind, and if his obnoxious or terrific qualities make him less attractive to mankind, his irresistible, demoniac strength will leave him the object of the most intense dread. His attributes as well as those of all other deities are the result of the climatic condition of the country or countries in which the religion took its origin. For American religions the term *chief deity* is preferable to that of supreme being or supreme god, for "*God*" is too anthropomorphic and "*supreme*" involves a position too high to be imputed to any of the deities found in American mythology.

After examining the religious beliefs of a large number of tribes and giving abstracts of the more important beliefs on this subject of chief deities, I arrived at the conclusion, *that the majority of all American tribes worshipping the sun regard the sun deity as their chief deity*. It is only the imperfect state in which tribal mythology is generally brought to our knowledge that prevents us from pushing our inquiries further in this direction. Even in the earliest prehistoric epochs the rudest savages must have comprehended that *to the sun* mankind owes not only its daily food and nightly rest, that the earth owes its fecundity to his balmy rays and the rains which cause the waters to flow everywhere; neither were they ignorant of the fact that man's life and existence are the sun's work and therefore worshipped in the solar spirit the creator of man, of plants, of animals, the earth and of the whole universe. In the eastern hemisphere sun worship has been largely superseded or placed into the background by other deities, chiefly of a moral or more abstract nature; but even there the features of this primeval cult are still perceptible to the trained eye in the religions of many tribes and nations.

The sun often appears in the form of two deities in the same tribal religion; one may be of an abstract, the other of a concrete aspect; or the deity is thought to rule in the sky, and his counterpart appears on the earth as a culture-hero with an apparently historical garb. The solar deity is always in conflict with the lunar god and the clouds, but not with the deity of the skies. The lunar god holds the position of a chief deity in a few religions, but never appears as the creator or maintainer of the whole earth and universe. When the sun is regarded as a female, the moon often,

Digitized by Google

though not always, appears as a male genius and in some tribes it is difficult to distinguish between solar and lunar god, because both celestial bodies are called *by the same term*.

Among the tribes, who worship the solar deity as their chief deity, are the following:

The Tupi god Tupan is a thunder god, but his attributes prove him to have been originally a solar genius. Tamo-i of the Guarani is "the old man of the sky," who is equivalent to the sun, like Tiri of the Yuracares, and the white-bearded Bótchika of the Muiska in Bogotá, while Dabaiba, on the isthmus of Panama, was probably a sun goddess also. In Peru three deities represented this celestial orb: Inti, Viracocha and Manco Capac; their worship originated at different epochs.

Tucapacha was the chief deity of the tribes of Michoacan. Coxcox of the Chichimecs. The Aztecs worshipped the sun in an abstract form in Tonatiuh, in a more concrete shape in Tezcatlipoca, who is the antagonist of the moon-god Quetzalcoatl, the latter corresponding to Kukulcan of the Maya religion.

A few of the Pueblo Indians of New Mexico worship Montézuma as their chief god, creator of the universe and culture-hero, while among the Californians the "chief above" or the "old man above" has a large number of votaries. Other Californians, like the Pit River Indians, regard the coyote-wolf as the principal deity and ascribe to him the creation of many objects in this world; the same may be said of a few Selish tribes on middle Columbia River, Washington Territory and Idaho, and of the Pápagos in Arizona. Coyote-worship is *originally* identical with lunar worship. The Wintún in northern California call their almighty power Noamkléstowa or "Great Spirit of the West." The main deity of the Klamath Lake and Modoc Indians of Oregon is K'muka'mtchiksh, the "primeval old man."

The Flathead-Selish of Montana pay their respects to a chief deity called Amotekēn, who is invisible and resides in the sky; he is possibly a genius of the skies, not of the sun. To the Niskwáli, Washington Territory, the chief deity is not the sun, but the moon, Slokwalm. The Haida Indians worship an abstract and a material sun-god, the former being the supreme ruler of the universe.

West of the Rocky Mountains we find among the majority of the tribes a deity called the *Master of Life*, the *Master of Breath*,

Digitized by Google

the *Great Spirit*, etc., and in addition to this, a series of solar deities differing among each other according to the tribes in which they are found. These are but the concrete expressions of what the *Master of Life* expresses in a more abstract form.

Sun deities and chief deities at the same time are: the Michabo of the Odshibwē, Areskui of the Hurons, Kutnähä or "midday sun" of the Shetimasha in Louisiana, the deer-god of the Floridian Timucua and many others. The sun-dance of the Sioux perpetuates sun-worship up to the present time, when a large proportion of them have become Christians.

INDIAN MIGRATIONS AS EVIDENCED BY LANGUAGE. By HORATIO HALE, of Clinton, Ontario, Canada.

[ABSTRACT.[1]]

IN this paper the author attempts to trace, by the evidence of language, reinforced to some extent by that of tradition, the course of migration which has been followed by the tribes belonging to some of the principal linguistic stocks of North America. The Cherokees are shown to belong to the Huron-Iroquois stock, but to have received accessions to their vocabulary from some other source. The Huron language is shown to be the oldest in form among the languages of this stock. The migration of the Huron-Cherokee tribes is traced in a course leading from the northeast to the southwest, that is, from the lower St. Lawrence to northern Alabama. The Dakotan stock is next considered. The Tuteloes of Virginia and North Carolina are shown to belong to this stock, and to speak a language which is older in its forms than the languages of the western Dakota tribes. The Algonkin tribes and languages are next examined, and the evidence is exhibited which shows that their migration probably flowed from Hudson's Bay and Labrador towards the south and west. The tribes of the Chahta-Muskoki family are noticed, and the fact is pointed out that their language, like that of the Cherokees, has apparently been modified by admixture with some alien speech. Some reasons are given for supposing that this speech was that of the Moundbuilders of the Ohio Valley. Traditionary and linguistic evidence is adduced

[1] This paper is published in full in the American Antiquarian for January and April, 1883.

Digitized by Google

to show that the Moundbuilders were conquered and partly exterminated by the Iroquois and Algonkins, and that the survivors, mingling with the Cherokees and Choctaws, caused great changes in the languages of those nations. The fact that the course of migration seems to have been from the Atlantic coast towards the interior is regarded as evidence that the ancestors of our Indian tribes were emigrants from Europe. In support of this opinion, reference is made to the close resemblance in structure between the Basque and the Indian languages. It is further suggested that if the Aryan intruders, entering Europe from the east, encountered and absorbed a population resembling the American aborigines, this fact would account for the great changes which the Aryan speech underwent in central and western Europe. It would also account for a very remarkable change which took place in the character of the intruding race. The Aryans, who in the east have always been a submissive and contemplative race, devoid of the idea of popular government, become in Europe a high-spirited, practical, and liberty-loving people. The conclusion is that the nations of modern Europe are a mixed race, forming a transition, in physical and mental traits, between the eastern Aryans and the aboriginal Americans.

THE KINSHIP SYSTEM AND MARRIAGE LAWS OF THE DHEGIHA, ILLUSTRATED BY CHARTS. By J. OWEN DORSEY, of Washington, D. C.

[ABSTRACT.[1]]

MARRIAGE laws based on kinship system, which, in turn, is founded on the gentile organization of the tribe. The last is affected by the customs pertaining to the buffalo hunt.

Chart I. The Omaha Tribal Circle, as formed during the hunt, and showing the gentes. The gentes divided into sub-gentes, for certain reasons. Father-right.

Chart II. "Consanguinities." Classes of the consanguinities of "SELF, a male."

Classes of the affinities of "SELF, a male," as shown in Chart III.

[1] The charts illustrating this paper are by necessity omitted.

Digitized by Google

Peculiarities of the charts caused by the marriage law: "SELF can marry any woman whom his wife calls *sister*, *brother's daughter*, or *father's sister*." Actual and potential kindred. The kinship formed by the calumet dance.

From the examples given in the charts, it is plain that among the Dhegiha, terms of kinship are used with latitude, differing from our ordinary acceptation of those terms. Then follows the full definition of each term. Women whom a man cannot marry. Men whom a woman cannot marry.

Women whom a man can marry. Men whom a woman can marry. Marriage of a brother's widow. Law concerning widows and widowers.

THE SUN DANCE OF THE OGALALLA SIOUX. By ALICE C. FLETCHER, of Cambridge, Mass.

THE sun dance is a tribal festival at which attendance is compulsory. The dance proper is a strictly religious rite, entered voluntarily and performed in fulfilment of vows made in sickness or trouble in order to secure health and prosperity. The dance proper is a centre about which many festivities cluster, incident to a great annual gathering. Thanksgiving and a desire for future benefits are the essential mental characteristics; the recognition of supernatural powers and dependence upon them, together with obligations of faithfully performing a vow are the religious characteristics; the exact observance of certain forms and rituals is demanded of the priests and their coöperation is needful to secure the full blessing sought through the ceremony by those taking part in it.

The festival generally occurs in the latter part of June or early in July and lasts about six days. The time is fixed by the budding of the *Artemesia ludoviciana*. The people camp in a circle, with a large opening at the east. In 1882, over 9,000 Indians were so camped, the diameter of the circle being over $\frac{3}{4}$ of a mile. The tent set apart for the consecrating ceremonies, which take place after sunset of the first day, was pitched within the line of tents, on the site formerly assigned to one of the sacred tents.

Digitized by Google

Any number of persons can dance, provided they have vowed to do so, but each year there can be but one Leader. All the dancers must conform to fixed rules and regulations. The dance may be divided into four degrees.

1. That which only the leader can pass through. He must vow, procure the articles for the ceremonial, abstain from forbidden things and actions, fast, dance, give away property, be scarified and tortured.

2. To vow, abstain, fast, dance, give away, be scarified and tortured.

3. To vow, abstain, fast, dance, give away, and be scarified.

4. To vow, abstain, fast, dance, and give away.

Twenty-two persons danced and passed these degrees as follows: First degree; the leader only. Second degree; one man. Third degree; seven men, one woman (I could learn of no woman ever having been tortured). Fourth degree; eleven men, one boy (11 or 12 years old).

The leader is required to make the vow, depend upon it for recovery, if sick, or deliverance, if in trouble. Soon after, he must set about fulfilling the duties of the vow. These are, to kill a buffalo, preserve the hide, which must never be taken into a lodge, keep the fat in skin bags, save the skull and two chips; lay away a red-stone pipe, the stem ornamented with porcupine quill-work; accumulate possessions to give away at the festival; abstain from running, swimming, loud talking, boisterous actions; live at peace and spend much time contemplating the fulfilment of his vow. In this manner the winter is passed. Early in June the leader selects a friend to be his assistant and these two proceed to one of the Holy-men, who has learned the ritual of the dance, and with certain ceremonies offer him the charge of the dance. From the moment of his acceptance, the leader places himself under the implicit guidance of this officiating priest. Every dancer chooses a lay assistant and a priestly guide. The leader's assistant, at the direction of the officiating priest, obtains an axe, awl, needle and four knives, all of which must be new; these are for the consecrating ceremonies and to be used in the rites. The officiating priest summons the people to the place selected for the festival.

The opening ceremonies begin with the entrance of the officiating priest and the leader, accompanied by their attendants, into the tent before mentioned. All are painted red and wear the buffalo robe in the sacred ceremonial manner, the hair outside, the head

Digitized by Google

on the left arm which is folded over the tail on the right arm. A fire is in the centre of the tent, a spray of sweet grass laid on it, the axe consecrated in the aromatic smoke and afterward used to cut the sod from an oblong space drawn on the earth back of the fire. The brown exposed earth is then mellowed, and a few live coals laid in the centre of the figure, sweet grass dropped on them, and through the smoke all the articles to be used during the ceremonial are passed for consecration, after having been first wiped with Artemesia. During this ceremony the priest chants the ritual, as he sits facing the east. The pipe is filled, smoked and passed, stem downward. The tent cloth is raised that all the people may hear the prayers chanted. These prayers are only spoken on this occasion, once a year.

The dancers every morning repair to this tent while certain rituals are sung, and in the evening they come here to dance and sing the songs of the festival. The people during these days enjoy feasts, dances, etc., incident to a reunion. The entire camp, however, is under the charge of men appointed by the priest to preserve order and carry out the regulations of the festival. On the fourth day the site of the pole is chosen by men set apart for the task, and the tree which is to serve as the pole is selected by young men appointed to the duty, and a man of known worth is designated to dig the hole for the pole. On the morning of this day the priest, leader and attendants repair to the selected tree, present the pipe, lifting the stem for the first time, after which a pipe is laid at the foot of the tree, a circle drawn on the ground near it, an offering of calico tied on the tree just below the branch which forks toward the east, and a man appointed to remain and watch the spot and suffer no living creature to pass over the consecrated ground. At noon the two singing societies repair to the place, and seven priests then light and smoke the pipe left by the leader, in accordance with special ceremonies. After this, five men and three girls are chosen to cut the tree, observing the order of procedure peculiar to this part of the festival. The tree is then struck with the sacred axe by the first young man, he recounting his claim to receive the honor; he leaves the axe sticking in the gash, the second young man pulls it out, lifts it, recounts his deeds, and strikes, leaving the axe in the tree, and so on by the five men, and the tree is thus girdled with gashes. The girls then fell the tree which must drop to the west. It is carried to the camp circle on a litter of sticks and must not be handled or stepped over.

Digitized by Google

Before it reaches the camp, the open circle is charged by all the able-bodied men in gala dress, their ponies decked and painted. They dash across the plain at full run, and skirt the outside of the line of tents. The pole is painted and the offerings tied upon it and erected with elaborate rites. After which a circular enclosure of boughs, having an opening at the east, and a roof formed of tent poles, resting on crotched sticks and covered with tent cloths. The poles and tent cloths are contributed by the different divisions of the tribe. The ceremony of peircing the children's ears is now in order, and a vast amount of possessions changes hands during these ceremonies. The rites incident to the puberty of girls take place at this time. On the following day at noon the embowered circle about the pole is charged by men on foot, who make four advances, led by the chosen warriors, and at the fourth charge, pass out at the eastern entrance. Soon after, the sun dancers enter, naked to the waist, with embroidered widths of cloth reaching nearly to their ankles and belted at their waists. Their feet are bare, on their heads are crowns of Artemesia with horns cut from rawhide and painted blue. In their hands are sprays of Artemesia. The leader carries in his arms the buffalo skull; with the priest followed by their attendants, they slowly pass round the circle by the south to east, the skull being placed opposite the pole and the entrance. The space behind the skull is occupied by the leader and officiating priest, the other dancers with their priests and attendants are to the right and left. The dancers have fasted, tasting neither food nor water, since the time the pole was cut, and they now dance, at intervals during the rest of the day and night and until after noon of the following day. When they dance they use a whistle which is made from the wing bone of an eagle, ornamented at one end by a peculiar, soft feather used in religious ceremonies. They blow this whistle to the rhythm of the song which is sung by the societies, accompanied by a drum made of a hide dried for this occasion.

On the morning of the sixth day, the buffalo skull is painted with a sign in blue color, indicating the four winds. An oval space is marked out on the earth behind it, the sod cut off and laid to the east of the oval; upon the top of this heap the skull is placed. The soil within the oval is then mellowed and a figure similar to that painted upon the skull is cut upon it, and into it tobacco is dropped. The soil of the oval and the skull are painted

Digitized by Google

with dashes of red ochre. A rest for the pipe is set up, just behind the oval, the bowl of the pipe put on a buffalo-chip, the rest supporting the stem. Artemesia is spread back of this and another buffalo-chip set further back to receive the ashes. Sweet grass is placed in given spots and offerings of food placed on the ground near the skull. At this time all the dancers are painted according to the visions of their respective priests. Scarifications are next performed. After noon, the leader is led to the pole, when according to certain ceremonies the flesh is punctured a little above the nipples by a wedge-shaped knife, and a stick having one end embroidered with porcupine quills is inserted. To this skewer the raw hide rope fastened to the pole is secured, and the man is led out toward the east until the rope is taut. A large amount of goods are then given away, and many ceremonies take place to insure him a speedy release. When a certain song is started, he must put his whistle in his mouth and bracing himself pull with all his force, until he shall tear the flesh loose. When one side gives way he raises his hand, palm upward to the sky, as a sign of thanks for the deliverance. With one man the struggle lasted nearly twenty minutes. When these tortures are completed the festival is over.

THE DAVENPORT TABLETS. By HORATIO N. RUST, of Pasadena, Cal.

[ABSTRACT.]

BELIEVING that the pictures on the Davenport Tablets lack evidence of great antiquity, and are the work of the Indians who were recent Moundbuilders, I took representations of the Tablets to the Dakotas, showing them to several of the older members of the tribe, telling them how they were found, and asking what they meant. The answers were in each instance substantially the same and without hesitation, viz.:

That the picture of the "mound" represents an earth lodge, in which a dance was being held.

The "prostrate forms" represented those persons who were overcome by the efforts and excitement of the dance.

Digitized by Google

The "curling smoke" arose from a fire in the lodge, indicating that the dance was held in cold weather.

The "moon and stars" signify that the dance was conducted in the night.

The "upright marks" around the lodge represent a fence of sticks set in the ground. A common custom among them to-day.

The irregular markings which some persons have tried to interpret as evidence of a written language, were simply ornamental markings conveying no intelligence.

Similar earth lodges destroyed by time and other causes have formed many mounds and groups of mounds, which now may be seen upon the benches all along the Missouri River.

A Find of Ceremonial Weapons in a Florida Mound, with brief notice of other mounds in that State. By A. E. Douglass, of New York, N. Y.

[ABSTRACT.]

While considerable attention has been paid to the sand and shell mounds upon the western or Gulf coast of Florida, as well as those upon the St. John's river and its tributaries, the mounds distributed in equal abundance along the Atlantic border of the State have up to the present time almost escaped notice. Gradually they are fading away under the corrosion of agriculture and the elements, and the more serious evil of the curiosity of relic hunters, intent simply upon the acquisition of some object of pecuniary value, indifferent meanwhile to the characteristics of the mound they destroy, and to the facts attending the locality of the objects obtained which may invest them with peculiar archæological value. Relics of metal have gone into the melting pot, and others of stone have been broken in the handling and finally thrown away and lost.

Employing a few weeks in each winter during the last four years, I have taken what I may call an enthusiastic interest in recording the characteristic features of and in excavating more

Digitized by Google

than forty of these sand mounds, comprising all that I was able to hear of, on a seaboard of about one hundred and twenty miles in length, and averaging twelve miles in width. This district, commencing about ten miles south of the mouth of the St. John's river, extends to the southern limit of Mosquito Lagoon, and comprises the eastern halves of St. John's and Volusia Counties. Like the seaboard of North and South Carolina and Georgia, the coast of Florida presents a continuous line of outlying islands or long and narrow peninsulas, wholly or partially separated from the mainland by salt water lagoons which afford navigable water channels for the entire distance of three hundred miles from the mouth of the St. John's to Jupiter Inlet, except when interrupted by narrow tongues of land connecting with the mainland which interpose in the aggregate about twelve miles of land carriage.

The *shell mounds* in the district I have explored are mostly found upon the coast islands or peninsulas, while the *sand* mounds are, with very few exceptions, found upon the mainland, and generally near to streams of fresh water, which, draining the swamps, hammocks and pine barrens of the back country empty into the salt lagoons. The relics found in the sand mounds were quite abundant in St. John's County, but became more infrequent as I entered the northeastern border of Volusia County. The mounds themselves, however, gradually increased in dimensions, averaging north of the Halifax river not over ten feet in height, while those south of Mosquito Inlet ranged in height from twelve to twenty-three feet. Another remarkable fact was the prevalence of the celt, sometimes abundantly, in the St. John's County mounds, while south of the northern extremity of the Halifax river, in an examination of eighteen mounds, not one of these implements appeared.

The first sand mound I had the pleasure of excavating was what was called the Sanchez Mound, about eight miles north of St. Augustine, on a point of land formed by the confluence of the North river and Guano Creek. Though of moderate dimensions, nine feet in height with a base diameter of seventy-five feet, it produced a most abundant yield of celts (24) in connection with many other interesting objects. Four of these celts I venture to submit for your inspection as samples of more than one-half the number, the remainder being but little inferior except in condition and by reason of injury. The workmanship of these objects could hardly

Digitized by Google

be excelled even with the superior tools we now possess, nor their symmetry more than equalled by the skilled artisan of the present day.

We estimated that there were over twenty original burials in this mound, if we may so term deposits of bones made after years of exposure to the elements had wasted all but the most substantial. These were deposited as nearly as we could ascertain about two feet above the original level of the ground, and occupied a circle of eighteen feet in diameter. Each cluster of bones was surmounted by the skull, and the whole mass encrusted with red paint which discolored the sand an inch or two around them, and proved a useful guide to the workmen in detecting their proximity. Only two flint spearheads were found, and it may be well to note that, in arrow and spearpoints combined, the aggregate product of forty-one mounds was less than twenty. This is a remarkable fact when we consider that the Spanish historians, without exception, make no mention of stone implements other than arrowheads in use by the Indians at the time of the discovery of Florida, while the abundance of celts exhumed in this and other mounds would indicate that at some previous time *they* were in general use. None of these celts were found in juxtaposition with the bones, but were scattered singly throughout the interior of the circle at depths from the summit plateau varying from two to six feet. No beads were found in this mound, but in others they were occasionally abundant and were generally found in quantities laid immediately upon the skull which capped each deposit of bones.

The most singular and interesting discovery, it has been my good fortune to make during these explorations, occurred while excavating Banner Mound, known generally throughout the country as Mound Oswald. This is situated upon a tongue of elevated land at the intersection of Tomoka creek with the Halifax river in the northeast section of Volusia County. This creek drains a large expanse of swamp lying some twelve miles east of the town of Volusia (upon the St. John's river) and is navigable from its mouth for a distance of ten miles for vessels drawing five feet water. Running for this distance nearly due north, it intersects the Halifax river, whose course is from northwest to southeast, at a very acute angle, and the point thus formed was under continued cultivation from early English times, say 1770 up to the Indian wars

Digitized by Google

of 1837–42, when the settlers were finally driven off, and since when it has been deserted. It is now covered with a magnificent park-like growth of oaks, palmettoes and pines. The surface slightly undulating is elevated on the average ten feet above the level of the water, and about a mile and a half from the extreme point forms a series of parallel ridges, possibly the vestiges of an ancient sea beach. Upon the western termination of one of these ridges, this mound was raised, the constructors, as is frequently the case, availing of the natural elevation to give a more imposing height to the structure on one side at least. Hence, while on the north its perpendicular height appears as fourteen feet, on the south where the natural depression has been increased by excation for materials, its height appears as twenty-four feet. On the north the slope of the mound rises abruptly at an angle of forty-five degrees, while on the south it rises gently to the summit at an angle of thirty degrees. The plateau on the summit (common to most of these larger mounds) was slightly convex and twenty-eight feet in diameter. The southern half of this plateau was covered with a dense scrub, while the centre and northern area was crowned with palmettoes, oaks, hickories and sweet bay, all of great size. A trench twelve feet long, and from three to five feet wide had been excavated by some previous explorer from the southeastern edge of the plateau to a point about eight feet north of the centre. Commencing with a depth of three feet it gradually descended to a depth of eight feet at its terminus. The fruits of this enterprise, undertaken as I understood some years before by a party attached to the Coast Survey, I never learned; had the result been fortunate no doubt it would have been continued over the entire surface; possibly therefore it proved a failure. The labor of clearing the surface of a large mound of the growth of scrub and timber is very considerable, and, without doing this, it is exceedingly difficult to estimate the true position of the centre toward which the excavation must usually be directed as likely to produce the best result. After clearing the plateau of trees (a work of severe labor and occupying several hours), we commenced a trench along the edge of the plateau, twenty feet in length, four in width and the same in depth. Occupying this, the six men were then faced toward an objective point on the opposite edge of the plateau, and we proceeded to excavate a triangular pit, descending as we advanced till at the centre we reached

Digitized by Google

a depth of fourteen feet. Before doing this, the surface of the mound was carefully raked over and the debris examined, as objects lightly buried are occasionally exposed by the wear and tear of storms for centuries, and might, without this precaution, be again buried. In this instance we found a stone ornament designed as we supposed to be used as the brooch for a necklace of shell. Our labor the first day was otherwise quite fruitless, but on the morning of the second day one of my crew, practised in the work, detected by the sound upon his spade a substance foreign to the sand, and dropping the implement went to work with his hands, and quickly unearthed a beautiful ceremonial weapon popularly known as a banner stone. Groping about the spot with his hands he encountered one after another until five had been brought to light all in perfect condition. They were lying upon the same plane, but a few inches from each other, and fourteen inches only beneath the surface. It was not till two hours later, that, working upon a lower level, he unearthed three more of the same objects. These latter were found immediately below the first five at a further depth of three feet, and were placed vertically one above the other, separated by a film or thin stratum of sand. With one exception these eight objects are as fresh and new, save a slight discoloration, as when they left the maker's hands. They are the only objects of the class I have ever found in the Florida mounds, nor have I heard of the discovery of any in the state. This fact coupled with the number in this find, and the evidently studied design in their arrangement, warrants me in considering them the stock of a manufacturer and trader in such objects, who had availed of this mound to conceal his store, while he singly disposed of them, or else finding his safety risked had sought to hide them until he could again venture into the neighborhood and resume his trade. All these objects, as I before said, are, with one exception, absolutely perfect. They might, save for a slight discoloration, have left the makers' hands but yesterday, so clean and finished and unblemished do they appear. This exceptional one, however, is plainly many centuries older. It is covered with an amount of patina only to be acquired by exposure for a vast period of time. Five of these objects are of this special pattern, and one of its characteristics is common to all the specimens, that is, the ridge which accommodates the perforation is on one side *rounded*, on the other *flattened*. It seems a fair in-

Digitized by Google

ference after inspecting these objects, that the maker becoming possessed of this ancient specimen used it as a pattern for the rest, and may have used it for many another.

This specimen (fig. 1) consists of two semicircular flanges, or

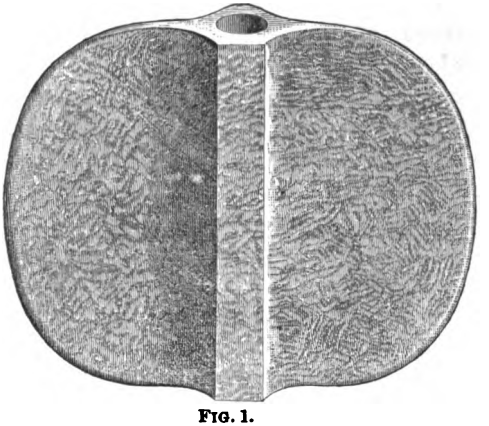


FIG. 1.

wings or blades of thin stone, starting on opposite sides from a thicker ridge perforated throughout its extent. From edge to edge of these flanges the distance is five and one-fourth inches, the length along the axis or ridge is four inches, the perforation throughout

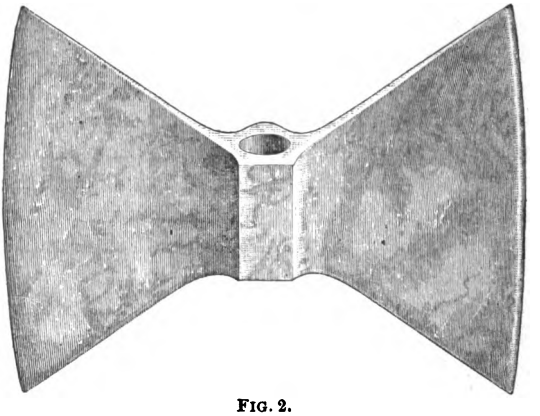


FIG. 2.

the length of the ridge is one-half inch in diameter and absolutely true. Two others of this pattern are about the same dimensions, and two others are slightly smaller. Again, two other specimens represent what may be called the double battle-axe pattern (fig.2).

Digitized by Google

The flattened edge of the blades forbids any idea of their having been intended or used for any warlike purpose. The distance from one edge to the other is, in one of these objects, five and a quarter, and in the other, five inches. These blades or flanges contract in width as they approach each other and merge into an axis or perforated ridge two and one-fourth inches in length, seven-eighths of an inch in thickness, while the perforation through its length is one-half inch in diameter. These two similar objects laid athwart each other would fairly represent a Maltese cross. The eighth specimen (fig. 3) differs from the first five, only in suppressing the ridge on one side of the object altogether, and thus having one surface absolutely flat, while a rounded ridge shows upon the other. The peculiarity of all these objects is the possession of this ridge flattened upon one side and rounded upon the other. Of one hundred and fifteen objects belonging to the class of cere-

FIG. 3.

monial weapons in my possession, these and one other in a fragmentary condition alone present this characteristic. It is remarkable how from the condition and arrangement of this deposit one can trace the mode in which the trader buried these objects, and mark his ingenuity as he continued to conceal and render secure a part, if not all, of his hoard.

Selecting for the purpose a mound which the local tribes would be little likely to disturb, he proceeded hastily to excavate a cavity wherein he could spread them at length. He needed an implement for the purpose, and the ancient specimen before you answered most admirably. Observe how the attrition of the hand holding it has polished the patina of the one flange, while the

Digitized by Google

other presents a roughened edge fractured and splintered through the overlying patina by the use to which he put it, and showing in the fracture the natural color of the stone. But, as he digs, his ingenuity finds display in separating the hoard into two parts, so that if one should be discovered the other part might escape detection. After clearing a space sufficiently long and wide to permit of his spreading the five at length, he sank in the centre a circular hole three feet in depth, the extreme length of his arm and implement, and here he deposited three of the objects one above the other, as they were found, filling up the hole with sand to the level above. All that remained was to spread out the five remaining specimens in the trough prepared for them, and heaping the sand above them by means of the same ancient tool, he finally thrust it into the end of the trench, and there it was my good fortune to find it with the rest, some four centuries, perhaps more, afterwards. It remains but to say that the mound proved entirely destitute of burials either original or intrusive, nor were any other objects of interest found. We worked diligently until our excavation had reached the point aimed at on the opposite edge of the summit plateau, but without result. I would say briefly that this whole district must in ancient times have supported a most abundant population. About two miles to the eastward upon the opposite shore of the Halifax river, a mound of shell débris extends for a distance of nearly ten miles along the shore. Its average elevation is about fifteen feet, and its width at base one hundred and fifty feet. It is clothed with matted vegetation upon the sides, and crowned with noble oaks and pines upon its ridge. Many other shell mounds and fields are found in the neighborhood, all witnessing an abundant population in the unknown past.

RECENT ARCHÆOLOGICAL DISCOVERIES IN VERMONT. By G. H. PERKINS, of Burlington, Vt.

[ABSTRACT.]

NOT far from Middlebury, Vt., some peculiar specimens have been found under conditions which make it probable that they are the oldest implements yet discovered in the state. The surface soil at this locality is a clay-loam about a foot in depth.

Digitized by Google

Under this is a yellow subsoil. An apple tree in the orchard of a farmer was uprooted and in clearing away the débris stone implements were discovered. This led to further investigation and by persevering efforts quite a collection of objects was obtained. These were in the yellow subsoil from 18 to 24 inches below the loam and from 30 to 36 inches below the surface sod. There was no evidence that the soil had been disturbed or that the objects found had been deposited in graves. The specimens are themselves peculiar, being unlike any others found in Vermont. The material is in most cases a brownish siliceous stone from which "turtle backs" and other large and rather rude objects had been flaked. Ground implements, as celts and other like objects also have been found and a short cylinder of hard-burned pottery. Another interesting locality which I visited last summer proved to be the site of a village. Old settlers near by say that fifty years ago many skeletons were found, but none can be found at present. However, from all the cultivated fields which border what is known as Bristol pond in Addison county, great numbers of implements have been obtained. These fields are many of them on hillocks and the soil is in some of them clay, in others sandy, and in either case there are few stones of any sort except angular fragments brought by the former occupants. These are of all sizes from masses weighing eight or ten pounds to small flakes, the latter predominating. Over considerable areas the ground is completely filled with flakes and the total amount of material which must have been transported from a considerable distance to this village is very great. Hammerstones are, or rather were, for the region has been thoroughly looked over, so abundant as to be gathered by the basketful, and I presume that first and last a small wagon load of these implements has been carried off from this locality. The flaked implements are peculiar in their large size and rudeness. The material is almost uniformly gray quartzite. It seems probable that the large flaked implements were used as hoes or spades. It is difficult to guess at any other use to which they may have been put. Well ground celts and axes, pestles, amulets, banner stones, etc., occur and also finely flaked knives and arrowpoints, but by far the greater number of specimens found are either rather rudely made "turtle backs," or triangular or lanceolate objects from three to six inches long and two to four inches wide. Frag-

Digitized by Google

ments of pottery of very good quality have also been found and one bone object, the tyne of a deer's horn notched at the base as if for the attachment of a cord. It is not supposed that this village site was occupied in very remote times—there is no evidence of that—but yet it must have been before the occupation of the country by white men, since had there been a settlement there then, some tradition or account of it would remain until now.

TITLES OF OTHER PAPERS READ IN SECTION H.

A SCHEME OF ANTHROPOLOGY. By O. T. Mason, of Washington, D. C.

ON THE COMPARATIVE PHONOLOGY OF FOUR SIOUAN LANGUAGES. By J. Owen Dorsey, of Washington, D. C.

NOTICE OF A COLLECTION OF SIOUX WEAPONS AND ARTICLES OF DRESS. By G. H. Perkins, of Burlington, Vt.

EXHIBITION OF A COLLECTION OF CHIPPED-STONE IMPLEMENTS FROM THE PACIFIC COAST. By H. N. Rust, of Pasadena, Cal.

WHO BUILT THE MOUNDS? By P. R. Hoy, of Racine, Wis.

WHO MADE THE NATIVE-COPPER IMPLEMENTS OF NORTH AMERICA? By P. R. Hoy, of Racine, Wis.

MONUMENTAL AND ART REMAINS IN THE LAKE REGIONS OF OHIO, PENNSYLVANIA AND NEW YORK. By Wills De Hass, of Washington, D. C.

ARCHÆOLOGICAL EXPLORATION: PROGRESS OF DISCOVERY. By Wills De Hass, of Washington, D. C.

MOUNTAIN ANTIQUITIES. By Wills De Hass, of Washington, D. C.

GEOLOGICAL TESTIMONY TO THE ANTIQUITY OF MAN IN AMERICA. By Wills De Hass, of Washington, D. C.

Digitized by Google

"PAGAN" IROQUOIS FESTIVALS. By Erminnie A. Smith, of Jersey City, N. J.

BELIEFS AND SUPERSTITIONS OF THE IROQUOIS INDIANS.[1] By Erminnie A. Smith, of Jersey City, N. J.

A FEW DEDUCTIONS FROM A "DICTIONARY OF THE TUSCARORA DIALECT." By Erminnie A. Smith, of Jersey City, N. J.

HOME LIFE AMONG SOME OF THE NORTH AMERICAN INDIAN TRIBES. By Alice C. Fletcher, of Cambridge, Mass.

THE BLEACHING OF THE ARYANS. WAS IT DONE BY THE LAW OF REPETITION; THE ACCUMULATION OF EFFECTS? By Virginia K. Bowers, of Newport, Ky.

INFLUENCE OF CLIMATE OF CANADA ON EUROPEANS. By Wm. H. Hingston, of Montreal, Canada.

STONE IMPLEMENTS OF BOMOSEEN AND CASTLETON RIVER VALLEYS. By John McNab Currier, of Castleton, Vt.

A STONE-GRAVE IN ILLINOIS[2]. By Charles Rau, of Washington, D. C.

ON COPPER IMPLEMENTS AND ORNAMENTS FROM NORTH AMERICA.[3] By F. W. Putnam, of Cambridge, Mass.

THE CONTENTS OF EIGHTY-FOUR STONE-GRAVES AT BRENTWOOD, TENN.[4] By F. W. Putnam, of Cambridge, Mass.

ACCOUNT OF THREE MOUNDS EXPLORED IN OHIO AND TENNESSEE.[4] By F. W. Putnam, of Cambridge, Mass.

DISCOVERY OF THE REMAINS OF A LOG STRUCTURE BELONGING TO THE STONE-GRAVE PERIOD IN TENNESSEE.[4] By F. W. Putnam, of Cambridge, Mass.

[1] Will be printed in full in Second Annual Report of the Bureau of Ethnology Smithsonian Institution.

[2] Published in the American Naturalist, 1883.

[3] Published in full with illustrations in 15th Report Peabody Museum of American Archæology and Ethnology, Cambridge, 1882.

[4] The substance of these three papers will be given in the 16th Report of the Peabody Museum of American Archæology and Ethnology, Cambridge, 1883.

Digitized by Google

Digitized by Google

SECTION I.

ECONOMIC SCIENCE AND STATISTICS.

Digitized by Google

Digitized by Google

PAPERS READ.

STATISTICS IN AGRICULTURE. By J. R. DODGE, of Washington, D. C.

[ABSTRACT.]

THE offices and utilities of statistics in agriculture are indicated in this paper. Among these are: — the effort to measure the extent of national resources, contrast the actual with the possible in production, to weigh the effect of over-production in reducing prices, to show the error of reliance on uncertain markets, and mark the correlation of the industries, and the progress of the sciences in their application to rural arts. It shows how the emigrating farmer is guided by the light of statistics in seeking a home, choosing a location suited to his new circumstances, deciding whether to sell or store his crops at harvest, and in successive seasons whether to enlarge or to restrict the area of a given crop.

It states that orderly and scientific presentation of present and future accumulations of results of feeding experiments, that reveal the mysteries of animal physiology, will soon bear an important part in solving the problem of successful meat production. In view of the fact that the increase of value of all feeding material is greater than the advance in price of the product, thus reducing the margin of profit, this has become a vital question — how to produce a larger percentage of meat from a given measure of nutrients in feeding. Data from present and future experiment stations will be useful in this work, especially in showing the loss in flesh-making by exposure, by irregularity in time or quantity of feeding, by excess of succulent feed at one season followed by a ration of peculiar harshness and dryness during another period. Such statistics may harmonize the discrepant views of chemists and feeders upon the value of ensilage and the utility of the silo, and show the physiological necessity for variety, and possibly teach how meat may be made in winter as well as in summer, on hay and grain as well as grass, and eventually teach how two pounds of meat may be made where one was made before, and on a proportionally less quantity of nutriment.

Digitized by Google

Statistics have also been useful in reducing the overweening egotism of the cotton interest, which once assumed the regency of production and the dictatorship of exchange. Now the cereals have assumed the lead in exportation, and the products of the plebeian swine equal in value half of the exports of the patrician crop. A revolution is in progress, aided by statistics, showing the superior economy in cotton production through its subordination to diversification and rotation in a general system of cropping, by which the cost of culture is reduced, and the net profit of production increased. The progress of the south is shown in agriculture, in social and commercial economies, and in manufacture of cotton. The prediction is made of the increase of this industry to a practical equality with the north and Europe in consumption of the raw product.

The effect of the coördination of the facts of sheep-husbandry upon that interest is given, showing that the results of breeding in increasing weight and density of fleece and capacity for flesh-taking have been followed by extension of flocks and increase of price; and that, on the contrary, the exhibit of sudden reduction of wool had swept the pastures as with a besom of destruction — as in 1868, when four millions of peltless carcases were rendered for their tallow. The causes are slight that lead to the reduction of numbers and the abandonment of this industry — so sensitive is it to fluctuations of price — and the necessity for a uniform tariff policy is emphasized by these facts. The increase of wool-growing, during twenty years, is a striking fact — from 75,000,000 pounds to 300,000,000, and from a value of $20,000,000 to $80,000,000. Then the United States produced scarcely half that was manufactured, now fully four-fifths, the imported fifth being largely of low-priced carpet wools.

The use of statistics in determining whether agriculture is progressive or retrogressive is referred to, and the conclusion reached generally favorable to progress. Wheat culture is exhibited at some length, as illustrative of several aspects of this progress. The remarkable fact in its history is a doubling of the area in fifteen years, while in thirty years the increase in production has been nearly four hundred per cent, an increase, not only keeping pace with the increase of the population, but furnishing more than twice the supply *per capita*, viz.: 4.33 bushels in 1829, 5.5 in 1859, 7.28 in 1869, and 9.2 bushels in 1879. The facts of distribution

Digitized by Google

are shown: only twelve states and two territories produced a surplus; the majority of the states failed to produce their own bread, and the causes of their failure in the several sections are duly shown. Illinois produced the largest quantity in the census year, followed in order by Indiana, Ohio, Michigan and Minnesota. The latter state produced *per capita*, 44 bushels to each inhabitant, Oregon 42, California 34, Nebraska 31. The movement of wheat-growing westward is thus shown as a percentage of the whole crop:—

	1849.	1859.	1869.	1879.
Atlantic Coast	51.4	30.7	20	12.8
Central Belt	43.3	54.6	49	49.9
Trans-Mississippi	5.3	14.7	31	37.3
	100	100	100	100

The production of wheat in five years has been enormous — an average of 425 million bushels per annum, of which (with twenty millions drawn last year from the average reserve in hands of farmers) 233 millions were consumed in the United States, 145 millions exported, and between fifty and fifty-one millions used as seed. The utility of statistics in fixing prices and failing speculation is offered, and it is intimated that in the last year of partial failure, a saving to farmers of twenty million dollars was made by the publication of national and state crop statistics.

NOTES UPON SOME METHODS AND RESULTS OF COLLECTING STATISTICAL MATTER BY MAIL. By CHAS. W. SMILEY, of Washington, D. C.

[ABSTRACT.]

STATISTICS are frequently laughed at, usually pushed aside as "dry" and sometimes analyzed to the serious discomfort of the author. At other times they are extolled and made the basis of the most important action. I am quite sure that these various treatments are usually just. Accurate and truthful statistics are very scarce and, when found, very valuable. Figures often do misrepresent terribly notwithstanding the charitable maxim that "figures never tell lies."

Whoever has prepared statistics or tested them knows that the great and fruitful cause of bad statistics is in bad methods of

Digitized by Google

collecting the data. The methods are not revealed on the face of the results and hence the insidiousness of this cause. Is it not therefore pertinent at the very opening of the Section of Statistics and Economic Science to consider the subject of methods?

Mailing circulars does not constitute the most effective method, but if rightly managed it is cheapest. It is especially economical in the government bureaus where postage costs nothing. The most effective method is by personal visitation of skilled agents. This, from its expense, is usually out of reach of private institutions and often out of reach of government officers. The method of personal visitation I could extol very highly from my own experience and from close examination of results of that kind of work performed by others, but the present purpose is to treat solely of the collection of material by mail. I will describe, as illustrative of the best methods, an extensive correspondence carried on in the office of the U. S. Fish Commission.

In July, 1879, it was proposed by Gen. F. A. Walker, superintendent of the Tenth Census and Professor Spencer F. Baird, Commissioner of Fish and Fisheries, to ascertain something of the extent and nature of the fish trade and consumption of fish throughout the entire U. S. In consequence there was prepared a three-paged circular with blanks for answers and containing 18 brief but comprehensive questions, such as:—

1. Do fish constitute an important article of diet in your town and in the adjacent country?

2. Where is the supply obtained?

3. Check on the following list the kinds commonly to be seen in the markets: (list given)

4. What is the average retail price per pound?

5. What kinds of fish are taken from your ponds and streams? Check on the following list: (list given)

8. Are salted and smoked fish sold?

9. What kinds? Check on the following list: (list given)

11. Are oysters brought to your place? How are they brought; in shell, in tubs, in cans? What is the usual price?

16. Answer same questions for clams and lobsters.

18. Is fish guano in its various forms used by your farmers?

With this was sent to every Postmaster in the U. S., a circular letter asking the assistance of himself or some one familiar with the facts and accompanied by a circular from the Postmaster General instructing Postmasters to furnish such information as could

Digitized by Google

be given "without prejudice to the duties of their offices." An addressed return envelope accompanied each circular.

The result of this sending in general terms was as follows:

41,517 Postmasters were addressed, from whom inside of 200 days 16,996 replies were received or 41 per cent. At the expiration of 200 days it was deemed best to send again, to those who had not answered, precisely the matter as had been sent before. This was done with a very gratifying result. 24,521 Postmasters were addressed from whom inside of 200 days 13,233 replies were received. In the 680 days that have since elapsed, but 155 more replies have arrived. This is much less than one per cent. The net result of two sendings was to get 73 per cent. of the reports desired.

Sending.	Circulars sent out.	Returns within 200 days.	Per cent of the sending returned.	Per cent of desired reports received.
I	41,517	16,996	41	41
II	24,521	13,233	54	32
Total	66,038	30,229		73

I should have preferred a third sending at the expiration of 200 days from the second. I estimate that a third call on the remaining 11,133 officers might have produced about 6,000 more replies and brought the per cent of results up to 86 per cent of what was desired.

I have taken 200 days as the limit of returns. The number that arrive after that is very insignificant. But it will be valuable to know what results to expect earlier. Taking the total of 16,996 replies which came in the first 200 days, the percentage which came in each of the ten 20-day periods was as follows:

Twenty-day periods.	Number of returns.	Per cent of all.	Days that had elapsed from the time of sending.	Per cent of what was destined to come which had arrived each twenty-day period.
First	9680	57	20	57
Second	4711	27	40	84
Third	1313	8	60	92
Fourth	604	3½	80	95½
Fifth	314	2	100	97½
Sixth	165	1	120	98½
Seventh	72	½	140	99
Eighth	65	½	160	99½
Ninth	42	¼	180	99¾
Tenth	30	¼	200	100
	16,996	100	200	100

Digitized by Google

The return within 200 days of 97½ per cent of all that would arrive within 200 days shows that, when subsequent calls are to be made, 100 days is a very good limit to fix at which to send again. The receipts under the second call were even more precipitate than the first, being augmented slightly by the driblets from the first call. It was as follows:

Twenty-day periods.	Number of returns.	Per cent of all.	Days that had elapsed from the time of sending.	Per cent of what was destined to come which had arrived each twenty-day period.
First	7862	59½	20	59½
Second	2796	21	40	80½
Third	998	7½	60	88
Fourth	790	6	80	94
Fifth	338	3	100	97
Sixth	238	2	120	99
Seventh	112	1	140	100
Eighth	33		160	
Ninth	11		180	
Tenth	3		200	

The case under consideration was a semi-official call upon all the states and territories and the effect of the call upon the different sections was very different. While the total yield of returns was 73 per cent of the offices addressed, 95 per cent of the Dakota offices answered, and but 61 per cent of the Louisiana offices answered. The per cent of answers for each state or territory was as follows:

Dak.	95	Utah	86	Me.	81	Mont.	80
Ind. T.	89	Mass.	85	Nev.	81	Fla.	79
Wash.	88	Vt.	83	N. H.	81	Del.	66
Wyo.	88	Oreg.	83	N. Y.	70	Tenn.	65
Idaho	87	Ohio	76	W. Va.	69	Ky.	65
Cal.	78	Colo.	75	Md.	69	Ga.	65
Iowa	78	N. Mex.	73	Ariz.	68	Miss.	64
Neb.	78	Mo.	72	Ark.	68	S. C.	63
Tex.	78	Ind.	71	Pa.	67	Ala.	63
N. J.	77	N. C.	70	Wis.	80	Va.	62
Ill.	77	Mich.	82	Conn.	80	La.	61
R. I.	87	Kans.	81	Minn.	80		

It was to be expected that states would answer according to their degree of education and intelligence and this is no doubt an element, but some other element has entered in here to place five western territories ahead of the best states. My own opinion is that the semi-official endorsement of the Postmaster General had

Digitized by Google

a far greater influence upon the new sections of the country than upon the older; that new officers answered partly because of the official endorsement and that old ones have become somewhat accustomed to disregard such endorsements. But why Dakota exceeded Arizona 27 per cent and the Indian Territory exceeded New Mexico 16 per cent I am unable to suggest except the possibility of the loss of mails in transit, by fire, wrecking, robbing of mail coaches, etc.

A grouping of the geographical sections yields some interesting results:

New England.		Great Plain Region.		Pacific Coast.		The North West.	
R. I.	87	Dak.	95	Wash.	88	Mich.	82
Mass.	85	Ind. Ter.	89	Oreg.	83	Kans.	81
Vt.	83	Wyo.	88	Nev.	81	Minn.	80
Me.	81	Idaho	87	Cal.	78	Wis.	80
N. H.	81	Utah	86			Iowa	78
Conn.	80	Mont.	80			Nebr.	78
		N. Mex.	73			Ill.	77
		Ariz.	68			Ohio	76
		Colo.	65			Ind.	71
Average	82	Average	82	Average	81	Average	78

Middle States.		South West.		South East.	
N. J.	77	Texas	78	Fla.	79
N. Y.	70	Mo.	72	N. C.	70
Pa.	67	Ark.	68	Md.	69
Del.	66	Ky.	65	W. Va.	69
		Tenn.	65	Ga.	65
		Miss.	64	S. C.	63
		Ala.	63	Va.	62
		La.	61		
Average	69	Average	68	Average	67

RECAPITULATION.

	Offices Addressed.	Ans. received in 680 days.	Per cent which answered.
New England	3176	2616	82
Great Plain Region	1381	1137	82
Pacific Coast	1528	1236	81
The Northwest	13157	10239	78
Middle States	7074	4905	69
The Southwest	8622	5865	68
The Southeast	6579	4386	67
Total	41517	30384	73

Digitized by Google

For quantity, these results were entirely satisfactory. The quality of the replies was of all grades. A very large per cent, however, bore internal evidence of truthfulness. A wise discretion was needed in the compilation but with skilled compilers excellent results could be produced. A discussion of methods of compilation, eliminating errors, etc., would be interesting but take too much time in this paper.

Let it not be supposed that these excellent results can be obtained only by government machinery. The official nature of this correspondence was a great aid, but I have obtained even better results from college men upon matters relating to their colleges and from specialists concerning their specialties. I therefore feel free to protest against the careless and inefficient work of this sort so often done by both public and private enterprise. Patience and perseverance in wise methods may not be all the qualifications that are necessary for good statistical work, but these are indispensable. Some of the suggestions to be made for success in collecting material are the following:

I. Make the questions very clear, concise and as few as possible. (Better send twice than totally break down by too long requests.)

II. If but one class of persons can be addressed from each of whom an answer is especially desired, send to all a first issue, to all who do not answer in 100 days a second issue, and to all who do not answer in 100 days more a third issue.

III. If more than one class of persons can give facts, address all of each class and after about 75 days address the delinquents a second time.

IV. Do not vary the matter sent the second time. Let it be an exact duplicate and be sent just exactly as if it had not been previously issued.

V. Leave blank lines between the questions so that no other paper is needed for reply, and if it can be put on a postal furnish it, even more for the sake of uniformity than for inducing people to reply.

VI. Always enclose an addressed envelope or postal for reply and provide that there be no expense to the respondent for postage.

VII. Remember that more or less of your circulars will be misdirected, lost in transit, fall into wrong hands, arrive during the

Digitized by Google

absence or sickness of your correspondents, be crowded aside for later answer or to get some needed information and then inadvertently overlooked, and so, do not lose faith in human nature but rather rejoice that amid so many contingencies you can get the material at all.

EXHIBITION OF SOME STATISTICS OF COLLEGE MEN. By CHARLES W. SMILEY, of Washington, D. C.

[ABSTRACT.]

THESE statistics relate to the graduates and non-graduates of Wesleyan University, especially the latter. They cover fifty years ending with 1881. The elaborate methods of collecting the data were described. Copies of eight tables were distributed to the members present. These are to be published in full in the ALUMNI RECORD of the college. The following summaries may be given to illustrate their scope.

I. TABLE SHOWING THE NUMBER IN EACH CLASS, THE LIVING, DEAD, ETC.

CLASSES.	Number of Non-graduates.	Number believed to be living.	Not certain whether living.	Numb'r dead.	Died before ent'r'ng life work.	Died since ent'r'ng life work.	No. of graduat's and non-graduat's	Per cent. who were not graduates*
1832-41	159	59	10	90	14	76	334	
1842-51	199	106	16	77	18	59	452	
1852-61	178	123	10	45	11	34	457	
1862-71	175	130	3	42	21	21	435	
1872-81	224	199	0	25	17	8	548	
TOTALS.	935	617	39	279	81	198	2226	
PER CT.	100	66	4 1-6	29 5-6	8 4-6	21 1-6		42

*This ran as high as 58 per cent in 1834 and 1867, and exceeded 50 per cent in eleven years; it ran as low as 21 per cent in 1875, and as low as 28 per cent in 1859.

II. TABLE SHOWING TIME OF LEAVING THIS COLLEGE, SUBSEQUENT PLACES OF STUDY, DEGREES, ETC.

CLASSES.	No. in the Classes.	Year of leaving this College.				No. who on leaving entered		No. who have attained Degrees.						
		Senior.	Junior.	Sophomore.	Freshmen.	Other Colleges	Profes. Schls.	A.B. or A.M.	M.D.	LL.B. or B.C.L.	LL.D. or D.C.L.	D.D. or S.T.D.	Ph.D.	Miscellaneous.
1832-41	159	26	33	52	48	32	12	38	12	2	5	4	0	0
1842-51	199	17	57	63	62	46	23	47	16	6	2	3	0	1
1852-61	178	8	42	60	68	60	28	56	21	6	2	2	0	1
1862-71	175	14	42	55	64	40	15	33	15	8	1	1	1	4
1872-81	224	19	38	70	97	35	18	20	7	10	0	0	1	6
TOTAL.	935	84	212	300	339	213	96	194	71	32	10	10	2	12
PR. CT	100	9	23	32	36	23	10	21	8	3	1	1		1

Digitized by Google

III. TABLE OF FAMILY STATISTICS.

CLASSES.	MARRIED.					Not married.	CHILDREN REPORTED.				
	Once.	Twice.	Thrice.	Total.	Unkn'n.		In families	Alive.	Dead.	Total.	Av'ge pr family.
1832–41	82	14	2	98	35	26	77	230	68	298	4
1842–51	111	15	0	126	39	34	98	312	78	390	3 4-5
1852–61	120	7	0	127	18	33	103	279	62	341	3 1-5
1862–71	108	6	0	114	13	48	93	192	35	227	2 1-5
1872–81	90	2	0	92	8	124	52	89	8	97	1 4-5
	511	44	2	557	113	265	422	1.102	251	1,353	3

IV. TABLE OF NATIVITIES.

Years.	Me.	N.H.	Vt.	Mass	R. I.	Ct.	N.Y.	N.J.	Pa.	South.	West.	Foreign.	Unknown.
1832–41	2	5	9	23	4	23	31	2	6	15	0	2	37
1842–51	5	10	4	24	2	24	50	4	5	10	0	9	52
1852–61	11	16	7	22	1	25	41	8	4	9	5	7	23
1862–71	15	9	9	27	1	24	24	9	5	6	7	9	30
1872–81	9	8	12	35	2	23	52	15	10	9	11	10	28
Totals.	42	48	41	131	10	119	198	38	30	49	23	37	169

V. PRESENT OCCUPATION.

In Ministry, Methodist Episcopal	85	(.09)[1]
Protestant Episcopal	13	(.01)
Congregational	6	(.01)
Baptist	4	
Other sects	9	(.01)
	117	(.12)
Lawyers	98	(11.)
Teachers	66	(.07)
Physicians	47	(0.5)
Dentists	2	
Editors, authors and purely literary work	20	(0.2)
Manufacturers	34	(.04)
General business pursuits	124	(.13)
Clerks	25	(.03)
Druggists	13	(.01)
Official positions, State or Federal	6	(.01)
Farmers	49	(.05)
Students	7	(.01)
Artists	4	(.01)
Army or Navy	3	
Out of employ	12	(.01)
Unknown	29	(.03)
Total number living non-graduates	656	(.70)
Number of deceased non-graduates	279	(.30)
TOTAL	935	(1.00)

[1] The small figures in parenthesis denote per cents; thus, 9 per cent of all non-graduates are in the Methodist ministry now, while 30 per cent are dead.

Digitized by Google

VI. Occupation since leaving College.

Occupation.	Number engaged.	Years spent.	Average years in each occupation.
Bishops	2	33	17
Ministry, Methodist Episcopal	136	1706	13
Protestant Episcopal	20	369	18
Congregational	11	107	10
Baptist	6	74	12
Presbyterian	4	75	19
Other sects	9	69	8
College Presidents	7	46	7
College Professors	17	157	9
Seminary Instructors and Tutors	10	70	7
Teaching professionally	94	1157	12
Teaching temporarily	100	264	3
Judges	7	68	10
Lawyers	144	2312	16
Physicians	82	1176	14
Dentists	2	46	23
Journalists	47	426	9
Authors	3	32	11
Manufacturers	37	611	17
General business	194	2365	12
Scientific work	2	46	23
State Legislatures	33	62	2
Members of Congress	4	14	4
Customs, Revenue, and Postal offices	11	83	8
Other public offices	19	47	2
Farming	66	868	13
Superannuated	8	53	7
Regular Army and Navy	11	70	6
Civil Engineers	10	127	13
Artists	4	32	8
Gentlemen of leisure	2	62	31
Mexican War	2	4	2
Federal Army,[1] 1861–5	92	220	2
Confederate Army, 1861–5	6	16	3

[1] Died during, or from injuries received in, the war, 22.

Digitized by Google

VII. COLLEGES ENTERED, BY 213 NON-GRADUATES OF WESLEYAN UNIVERSITY, AFTER LEAVING THIS COLLEGE.

The Colleges entered, and the number who went to each, were as follows:

Union	45	Asbury, Lafayette, Ohio Wesleyan, Madison, St. John's College, University of Pennsylvania, University of Virginia, and Williams, each 2	24
Yale	23		
Amherst	14		
Dartmouth	14		
University of the City of New York	13		
Brown	12	Alexandria, Baldwin, Columbia, Cornell, Emory, Franklin and Marshall, Illinois Wesleyan, Iowa Wesleyan, Kings, Northwestern, Norwich, Rutgers, University of Vermont, U. S. Naval Academy, and Willoughby, each 1	15
Dickinson	9		
Boston	7		
Harvard and Trinity, each 6	12		
Syracuse, West Point, and University of Michigan each 5	15		
Middlebury	4		
Bowdoin and Princeton each 3	6		
Augusta, Genesee, Hamilton, Hobart, Indiana,			213

SOME FACTS RELATIVE TO THE U. S. CENSUS OF 1880. By CALVIN S. MIXTER, of Washington, D. C.

[ABSTRACT.]

THE following table shows the population of the United States

Digitized by Google

by age and sex, classified as Native White, Foreign White and Colored,[1] according to the United States Census of 1880.

AGES.	ALL CLASSES.			NATIVE WHITE.		FOREIGN WHITE.		COLORED.	
	Total.	Males.	Females.	Males.	Females.	Males.	Females	Males.	Females
All ages.	50,155,783	25,518,820	24,636,963	18,609,265	18,234,026	3,521,635	3,038,044	3,387,920	3,364,893
Under 1 year.	1,447,983	734,024	713,959	617,307	595,430	2,989	3,061	113,728	115,468
1 year.	1,256,956	638,032	618,924	534,030	515,491	5,020	5,066	98,982	98,367
2 yrs.	1,427,086	726,038	701,048	601,683	579,272	6,893	6,752	117,462	115,024
3 yrs.	1,381,274	697,209	684,065	577,733	563,881	7,797	7,801	111,679	112,383
4 yrs.	1,401,217	712,406	688,811	587,440	565,513	8,557	8,435	116,409	114,863
Under 5 yrs.	6,914,516	3,507,709	3,406,807	2,918.193	2,819,587	31,256	31,115	558,260	555,105
5 to 9 years	6,479,660	3,275,131	3,204,529	2,694,398	2,625,324	61,803	60,894	518,930	518,311
10 to 14 years	5,715,186	2,907,481	2,807,705	2,361,832	2,280,260	120,740	117,699	424,909	409,746
15 to 19 years	5,011,415	2,476,088	2,535,327	1,965,748	2,007,090	184,320	194,492	326,020	333,745
20 to 24 years	5,087,772	2,554,684	2,533,088	1,945,279	1,928,938	274,038	254,217	335,367	349,933
25 to 29 years	4,080,021	2,109,741	1,970,880	1,472,960	1,397,625	365,094	306,022	271,687	267,233
30 to 34 years	3,368,943	1,744,308	1,624,635	1,128,308	1,088,315	419,769	342,862	196,231	193,458
35 to 39 years	3,000,419	1,527,159	1,473,260	920,264	938,963	432,957	356,308	173,938	177,989
40 to 44 years	2,468,811	1,243,773	1,225,038	726,832	751,013	384,931	327,959	132,010	146,066
45 to 49 years	2,089,445	1,078,695	1,010,750	621,164	609,787	340.893	290,078	116,668	110,885
50 to 54 years	1,839,883	936,702	873,181	538,133	512,672	318,045	259,042	110,524	101,467
55 to 59 years	1,271,434	674,927	596,507	403,260	378,541	203,820	166,294	64,847	51,672
60 to 64 years	1,104,219	584,858	519,361	345,575	321,270	170,841	139,622	68,442	58,469
65 to 69 years	725,876	379,498	346,378	243.803	232,245	98,028	83,333	37,667	30,800
70 to 74 years	495,442	250,001	245,441	165,062	164,476	59,590	55,019	25,349	25,946
75 to 79 years	281,065	138,601	142,464	94,598	99,574	31,106	29,590	12,897	13,300
80 to 84 years	146,362	67,941	78,421	44,492	51,949	15,156	15,930	8,293	10,542
85 to 89 years	49,835	21,908	27 927	14,858	19,425	4,419	5,096	2,631	3,406
90 to 94 years	16,100	6,351	9,749	3,486	5,357	1,270	1,690	1,595	2,702
95 to 99 years	4,763	1,855	2,908	783	1,260	433	575	639	1,073
100 and over	4,016	1,409	2,607	237	355	156	207	1.016	2,045

[1]The colored population includes 105,465 Chinese, 66,407 Indians (not in tribal relations), and 148 Japanese, whose ages have not yet been separately compiled.

Digitized by Google

TITLES OF OTHER PAPERS READ IN SECTION I.

ON INTERNATIONAL STANDARD TIME. By E. B. Elliott, of Washington, D. C.

SUGGESTIONS OF ELECTRICAL UNITS. By E. B. Elliott, of Washington, D. C.

POPULATION STATISTICS OF THE CHEROKEES. By E. B. Elliott, of Washington, D. C.

ON CERTAIN GOVERNMENT SECURITIES. By E. B. Elliott, of Washington, D. C.

UPON THE INVESTMENT OF LABOR AND CAPITAL IN FOREST CULTURE AS COMPARED WITH OTHER PRODUCTIVE INDUSTRIES. By Franklin B. Hough, of Lowville, N. Y.

THE JESSUP COLLECTION TO ILLUSTRATE AMERICAN FORESTRY, IN THE MUSEUM OF NATURAL HISTORY, CENTRAL PARK, NEW YORK. By Albert S. Bickmore, of New York, N. Y.

ON METHODS OF OBTAINING REGISTRATION OF VITAL AND OTHER STATISTICS OF THE OMAHA AND COGNATE TRIBES OF INDIANS. By J. Owen Dorsey, of Washington, D. C.

REFERENCES TO SOME OF THE ECONOMIC AND SCIENTIFIC PRINCIPLES IN TREE-GROWTH AND TREE-DESTRUCTION. By James Hyatt, of Stanfordville, N. Y.

STANDARD TIME FOR NORTH AMERICA. By Winslow Upton, of Washington, D. C.

EXPERIMENTAL PLANTATION OF EUCALYPTUS NEAR ROME. By Franklin B. Hough, of Lowville, N. Y.

COÖPERATION OF OBSERVATIONS FOR MAINTAINING ACCURATE TIME. By J. Rayner Edmands, of Cambridge, Mass.

Digitized by Google

EXECUTIVE PROCEEDINGS.

REPORT OF THE GENERAL SECRETARY.

WEDNESDAY, AUGUST 23, 1882.

THE thirty-first annual meeting of the AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE was called to order in the William Molson Hall of McGill University, Montreal, shortly after ten o'clock, by the retiring President, Prof. GEORGE J. BRUSH of New Haven, who introduced to the members the President for the coming year, Dr. J. W. DAWSON of Montreal.

President DAWSON then took the chair and spoke as follows:—

Ladies and Gentlemen of the Association:

I need hardly say how highly I esteem the honor you have done me in my election as your President for the present meeting. The unanimous election of a body like this to such an office is, in my judgment, the greatest distinction to which any scientific man on this continent can aspire, and I value it accordingly.

I have no doubt, however, that in the present case, the choice was in some degree determined by the wish to do honor to Canada, and to give to this meeting a character as thoroughly international as possible.

But this view of the reasons for the election by no means detracts from its value. On the contrary, it places the presidency of this association on a broader basis than that of any other office by extending over all this wide continent and including all that belongs to the powers that reign both at Washington and Ottawa. Science from her serene height thus overlooks all national boundaries and comprehends this whole world in her scope of vision.

It becomes your duty, therefore, for the time being, to merge the character of citizens of the United States or of Canada in that of cosmopolitan men of science. This is what I propose to attempt in endeavoring to perform the duties to which you have called me; and you will, therefore, kindly regard me not as a Canadian, or as an American, in the narrower sense of that term, but as the President of a society which, in meeting here, assumes a continental and international character.

THE PRESIDENT then requested the Anglican BISHOP OF MONTREAL to invoke the divine blessing on the Association's meetings, after which ceremony the PRESIDENT called on Dr. T. STERRY HUNT, Chairman of the Local Committee, who spoke as follows:—

In welcoming in the name of the Local Committee the American Association for the Advancement of Science to our city on the occasion of this, its thirty-first meeting, a crowd of memories rise to mind, many of which will be shared alike by citizens of Montreal and by my colleagues

Digitized by Google

of the Association. Twenty-five years have passed since this Association met here in August, 1857, under the presidency of Prof. James Hall, who honors us with his presence again to-day. Of the Local Committee of that time only four are now with us; Dr. Dawson, the President-elect of the Association, Dr. Hingston and Mr. Charles Garth, both members of the Executive Committee for this meeting, and myself. Those who were with us on that occasion will note great changes and great progress alike in the Association and in ourselves. Montreal was then a city of 60,000, and has to-day a population of 150,000 souls. The infant university, of which Dr. Dawson had just then assumed the direction, has under his wise care attained a vigorous and flourishing manhood, and the collections in natural science, gathered with few exceptions during his administration, now suffice to fill the great museum just completed and presented to the University by the generosity of a citizen of Montreal.

Not less remarkable is the growth of our Association, which has in the meantime increased more than fourfold, and now numbers nearly 2000 members. The history of this and its related associations demands a word in passing. Unlike national academies or royal societies these are popular bodies, inviting to their membership all who have an interest in the Advancement of Science, holding their annual meetings in different cities of their respective countries and so performing a kind of missionary work. The parent of all these is the German Association founded more than half a century since by the venerable Oken. Next in order of time comes the British Association, which held its fiftieth anniversary at York last year under the presidency of Sir John Lubbock, and to-day meets again at Southampton, with Dr. C. W. Siemens as president. Two of its honored past-presidents, W. B. Carpenter and Samuel Haughton, are with us, as our guests, to-day. Next in order of time comes our own Association, of which more anon; and last, but not least, the young French Association for the Advancement of Science, which was born with the new French republic, and met last year in Algeria, bearing back across the Mediterranean the torch of science to the soil of northern Africa, which ages before had been the cradle of arts and sciences. It was in May, 1881, that the French nation carried the war of science into Africa, well supported by allies from other lands, among whom was our distinguished Hungarian guest of to-day Dr. Szabó, of Budapest.

But to return to our own organization: the American Association, though it reckons its meetings only from the year 1849, has an earlier history. In 1842 there was formed a little band of workers under the name of the American Association of Geologists and Naturalists. To this body I, at that time a student in the University, was admitted on the occasion of its meeting at New Haven in May, 1845. The scope of this association was, however, not large enough. The claims of physics, of chemistry and of mathematics, all indispensable allies of geology and of natural history, soon made themselves heard in our meetings, and the success which had attended the German and British Associations already mentioned led to its reconstruction and enlargement with its present

Digitized by Google

organization and title. This was effected at Philadelphia in 1848, and with the subsequent history of the Association you are more familiar. Thirty-four years have thus passed, and we are to-day holding our thirty-first meeting. In its earlier days, the Association occasionally tried the experiment of two meetings annually, but the plan of a spring gathering was soon abandoned. Afterwards, during the late civil war, came an interruption of five years, during which the deliberations of our Association were silenced by the clash of arms, until its meeting in Buffalo in 1866; since which time its gatherings have been held annually.

From an early period in its history it was felt that this Association should be in its widest sense North-American. Science knows no political boundaries, and the policy adopted by our organization was continental. This was due in no small degree to the importance of the work of the Geological Survey of Canada, which, begun in 1842, had early drawn the attention of naturalists to this country. To this field of service I had come from my native Connecticut as early as 1847, and Professor James Hall, though persistently rejecting the repeated overtures which were made to him to join the Canadian survey, had at intervals given it the benefit of his great knowledge of American geology and paleontology. Hence it came about that in response to an urgent invitation from the people of this city the American Association for the Advancement of Science first met in Montreal in August, 1857, Prof. James Hall being president. The late Sir William Logan, at that time my chief, and the director of the Geological Survey, was then chairman of the Local Committee, while I was secretary of the Special Committee on Invitations.

And now twenty-five years have come and gone, and true to its continental character the American Association once more comes to Montreal to hold its annual meeting, having elected for its presiding officer the honored president of our University, and for its general secretary a representative naturalist from the province of Ontario. It has returned to find Montreal grown to a great metropolis, busy with manufactures and commerce, its wharves lined with ocean-steamers and ships of all nations; while it boasts at the same time that the growth of letters and science has kept pace with its material progress, and invites the members of the Association to visit its churches and asylums, its schools and its museums. It can only tell you with feelings of disappointment that the Geological Survey, with its valuable library and its extensive museum, has now left Montreal, having been last year removed to Ottawa, the seat of the federal government; while we at the same time regret that the duties of its present director, Dr. Selwyn, have, by calling him to the provinces of the far northwest, prevented him from meeting with us on this occasion.

The plan and scope of our Association, like that of its European sisters, is eminently popular, since it invites to its membership all those who by their attendance and their contributions are willing to show their interest in our objects. It is at the same time eminently conservative in its organization. Within the wide circle of its members, or associates as they might be called, is a select body of fellows, to whom alone, by the con-

Digitized by Google

stitution, is intrusted the government of the body. These are under the present revised constitution carefully selected from the members for their scientific attainments, and are alone eligible for office in the Association. Moreover, those who have had the honor of filling the chair of president of the Association are perpetual members of its governing body, the Standing Committee.

So much in my capacity of an original member, fellow and past-president of the Association, I have ventured to recall for the information alike of citizens and the younger members of the Association. To all its members who have now honored us with their presence I would say that the Local Committee, not unmindful of the importance of the American Association, and of the distinction conferred on this city in choosing it as a place of meeting, has spared no pains or care to do honor to its guests, and now bids you a hearty welcome.

The MAYOR OF MONTREAL was next introduced and welcomed the members of the Association to the city in the following words:—

Mr. President, Ladies and Gentlemen:

I feel highly honored at having the very pleasant duty to perform of welcoming those gentlemen from the different parts of America — from the Dominion of Canada and the United States — who have met here to discuss questions which interest the whole of humanity — a welcome, gentlemen, which the citizens of Montreal and the City Council have heartily voted to the different Associations of scientific men — the Forestry Congress, as well as this American Association for the Advancement of Science — who have met here and are now daily meeting to discuss questions of the utmost importance. I have every hope and confidence that your deliberations will result in great improvements in the different branches of Science. Mr. President, on behalf of the citizens of Montreal, I welcome all those who are attending the American Association for the Advancement of Science, the American Forestry Congress and the Society for the Promotion of Agricultural Science, and I am authorized to offer you the freedom of the city.

President DAWSON then read a letter from His Excellency THE GOVERNOR GENERAL, regretting his absence, and also announced that His Honor, Lieutenant-Governor ROBITAILLE had expected to be present to address a few words of welcome to the members, but had been unexpectedly called to a distant part of the Province.

Dr. THORBURN, of Ottawa, who was next called on, said that at a public meeting recently held in that city, steps had been taken to give a hearty welcome to those members of the Association who might visit the capital. Ottawa had many attractions and he felt sure that the members would be pleased with their visit and trusted that as many as could would favor his fellow-citizens with their presence on Saturday next.

The PRESIDENT then said:— It falls to me, gentlemen, to acknowledge on behalf of the Association, the welcome which you have given it. In

Digitized by Google

doing so, I have the advantage of knowing from personal observation the zeal and energy which have been displayed by the members of the Local Committee, and the enthusiasm kindled by the occasion in the minds of the citizens generally. The occasion is undoubtedly one worthy of the interest it has excited, not only in this and neighboring cities but in Canada generally. By its selection for the meeting of this Association, Montreal becomes for the time the scientific capital of North America, from which will go forth decrees more potent than those of parliaments, and to which will be turned the eyes of all interested in the progress of Science and the Scientific Arts. You do well to esteem highly the position thus conferred and to sustain it in the future by the actions of your own local institutions.

The fact that we can congratulate ourselves on this occasion in the presence of so many and so eminent men of science from the other side of the Atlantic is largely due to the exertions of the Local Committee and to the liberality of the citizens of Montreal. I had the honor in 1856 to be the spokesman of a delegation which went to Albany to invite this Association to hold the meeting in Montreal in 1857, which has been referred to. That meeting was a most successful one, though, no doubt, far inferior in numbers to the present. It benefited this Association and the interests of science, and gave a stimulus to the cause of scientific education and research in Montreal, the effects of which still remain. May the present meeting be still more agreeable and useful. Of the leading men of science who took part in the meeting of 1857 many have passed away: Henry, Logan, Bache, Pierce, Munroe, Billings and Morgan are among these. But many of the men who then stood high in science are with us to-day, and you now welcome a large number of men who have since that time risen into eminence, and of still younger men whose names will yet be widely known. To such young and rising men you should, and I know do, extend a welcome as hearty as to those who are their seniors and are better known to you. You welcome here to-day a much larger body than that which you received in 1857. This is evidenced not only by the larger number of members, but by the increased number of sections. In 1857 there were two sections and a sub-section. Now there will be no less than nine sections meeting simultaneously. I have only to add, on behalf of the Association, that the ordinary meetings of the sections, and those evening-meeting addresses which will be advertised, are open to all who may desire to benefit by them; and that the membership of the Association is open to all suitable applicants on very easy terms. Such entertainments and excursions as have been provided by the Local Committee or by local institutions and private individuals, are of course limited by the invitations these may issue, but I have no doubt they will be made as general as the circumstances will permit.

The PERMANENT SECRETARY announced that the financial report of the year had been presented to the Standing Committee and would appear in the volume of Proceedings. Several subscriptions had come in for re-

Digitized by Google

printing volumes of the Proceedings of the Association, among others one from Gen. William Lilly of $1,000 for reprinting volume twenty-six, and since he had come to Montreal he had received another contribution of $850 for a similar purpose from a member, who for the present wished to remain unknown. He also stated that one hundred and sixty papers had already been entered for this meeting and referred to the various sections.

Dr. T. STERRY HUNT, on behalf of the ART ASSOCIATION, invited the members to visit the Art exhibition.

The PERMANENT SECRETARY then stated that notices of the decease of the following members of the Association had been received since the last meeting:

THOMAS ALLEN, of St. Louis, Mo. Joined the Association at the 27th meeting. Died April 8, 1882.

ZACHARIAH ALLEN, of Providence, R. I. An original member. Died March 17, 1882.

JOHN G. BARNARD, of New York, N. Y. Joined at the 14th meeting. Died May 14, 1882.

GEORGE S. BLACKIE, of Nashville, Tenn. Joined at the 26th meeting.

ALBERT D. BRIGGS, of Springfield, Mass. Joined at the 13th meeting. Died Feb. 20, 1881.

LEVI S. BURBANK, of Woburn, Mass. Joined at the 18th meeting. Died Aug. 20, 1880, in his 52d year.

Mrs. MARY H. CAMPBELL, of Crawfordsville, Ind. Joined at the 22nd meeting. Died Feb. 27, 1882.

FREDERICK COLLINS, of Washington, D. C. Joined at the 28th meeting.

J. M. CRAMP, of Wolfville, N. S. Joined at the 11th meeting. Born July 25, 1796. Died Dec. 6, 1881.

CHARLES F. CROCKER, of Lawrence, Mass. Joined at the 22nd meeting. Died in July, 1881.

E. A. DALRYMPLE, of Baltimore, Md. Joined at the 11th meeting. Died Oct. 30, 1881.

CALEB G. FORSHEY, of New Orleans, La. Joined at the 21st meeting. Died in Aug., 1881.

W. W. GLAZIER, of Key West, Fla. Joined at the 29th meeting. Died Dec. 11, 1880.

J. GOLDMARK, of New York, N. Y. Joined at the 29th meeting. Died in April, 1882.

GEORGE W. HAWES, of Washington, D. C. Joined at the 23d meeting. Born Dec. 31, 1848. Died June 22, 1882.

THOMAS POTTS JAMES, of Cambridge, Mass. Joined at the 22nd meeting. Born Sept. 1, 1803. Died Feb. 22, 1882.

LEWIS H. MORGAN, of Rochester, N. Y. Joined at the 10th meeting. Born Nov. 21, 1818. Died Dec. 17, 1881.

WILLIAM H. MUSSEY, of Cincinnati, Ohio. Joined at the 30th meeting. Born Sept. 13, 1818. Died Aug. 1, 1882.

Digitized by Google

CHARLES H. PAYN, of Saratoga Springs, N. Y. Joined at the 28th meeting. Died in 1881.

J. DUNCAN PUTNAM, of Davenport, Iowa. Joined at the 27th meeting. Born Oct. 18, 1855. Died Dec. 10, 1881.

WILLIAM BARTON ROGERS, of Boston, Mass. An original member. Born Dec. 7, 1804. Died May 30, 1882.

ELIHU ROOT, of Amherst, Mass. Joined at the 25th meeting.

WILLIAM SHEPPARD, of Drummondville, Quebec. Joined at the 11th meeting. Born in 1783. Died in 1867.

DAVID P. SMITH, of Springfield, Mass. Joined at the 29th meeting. Died Dec. 26, 1880.

CHARLES SPINZIG, of St. Louis, Mo. Joined at the 27th meeting. Died Jan. 22, 1882.

A. REMSEN THOMSON, of New York, N. Y. An original member. Died in Oct., 1879.

WILLIAM S. VAUX, of Philadelphia, Pa. An original member. Born May 19, 1811. Died May 5, 1882.

GOUVERNEUR KEMBLE WARREN, of Newport, R. I. Joined at the 12th meeting. Died Aug. 8, 1882, in his 64th year.

J. CRAIG WATSON, of Ann Arbor, Mich. Joined at the 13th meeting. Born Jan. 28, 1838. Died Nov. 23, 1880.

MRS. G. O. WELCH, of Lynn, Mass. Joined at the 21st meeting. Died in June, 1882.

CHARLES M. WHEATLEY, of Phœnixville, Pa. An original member. Died May 6, 1882.

LEWIS E. WHITING, of Saratoga Springs, N. Y. Joined at the 28th meeting. Born March 7, 1815. Died Aug. 2, 1882.

This list includes the names of five original members, two past-presidents, and the treasurer of the Association.

The GENERAL SECRETARY announced that the Standing Committee recommended for membership in the Association the members of the Local Committee in Montreal and one hundred and sixty-nine other persons whose names were read to the meeting. On motion, the GENERAL SECRETARY was instructed to cast an affirmative ballot for the election of the parties named, who were then declared duly elected members of the Association.

The PRESIDENT announced that the following named gentlemen from abroad, who were present as invited guests of the Association, had been nominated for membership by the Standing Committee, and they were duly elected by the Association.

Dr. JOSEPH SZABÓ, Royal Counsellor, Professor of Geology and Minereralogy, Budapest, Hungary.

CHARLES WELD, Professor of Histology, University of Vienna.

Dr. WOLDEMAR KOWALEVSKY, Professor of Geology, University of Moscow.

Dr. RUDOLPH KŒNIG, of Paris.

Digitized by Google

Rev. SAMUEL HAUGHTON, Trinity College, Dublin.
GEORGE FRANCIS FITZ GERALD, Trinity College, Dublin.
W. S. MCCAY, Fellow of Trinity College, Dublin.
ALFRED HAMILTON ORMSBY, Barrister-at-Law, Dublin.
Rev. Prof. WILTSHIRE, King's College, London.
Dr. JOHN RAE, F. R. S., LL. D., Kensington, London.
WILLIAM B. CARPENTER, C. B., M. D., London.
Dr. J. W. GILBERT, Rothamsted, England.
JOHN COX, Warden of Cavendish College, Cambridge.
ERNEST H. COOK, Bristol University School, Bristol, Eng.
J. S. PHENÉ, LL. D., F. S. A., F. G. S., London.

The PRESIDENT also announced that the annual meeting of the British Association opened on the same day with this meeting.

The recommendation of the Standing Committee that the hours of meeting each day, except Saturday, should be from 10 A. M. to 1 P. M., and from 2.30 to 5 P. M., was adopted.

The General Session was then declared adjourned for the meetings of the Sections in their respective rooms for organization.

SECTION A. *Mathematics and Astronomy.*

In the absence of the Vice President, WM. HARKNESS of Washington, the Section was called to order by the Secretary, H. T. EDDY of Cincinnati, and W. A. ROGERS of Cambridge was elected temporary Chairman.

W. W. JOHNSON of Annapolis was elected to the Standing Committee, W. W. PAYNE of Northfield to serve on the Nominating Committee, and the following Sectional Committee was elected: G. W. HILL of Washington, LEONARD WALDO of New Haven, C. A. YOUNG of Princeton.

The Subcommittee, to act with the Vice President and Secretary in recommending to the Nominating Committee the Vice President and Secretary of the next meeting, was elected as follows: F. H. SHERMAN, Nashville, R. W. WILSON, Cambridge, C. H. ROCKWELL, Tarrytown.

The Section then adjourned until 2.30 P. M.

In the afternoon, in the absence of the Vice President, his address was read by J. R. EASTMAN of the U. S. Naval Observatory.

SECTION B. *Physics.*

Section called to order by Vice President T. C. MENDENHALL of Columbus, CHAS. S. HASTINGS of Baltimore, Secretary.

Fellow elected to Standing Committee: E. W. BLAKE, Providence.

Sectional Committee: C. K. WEAD, Ann Arbor, A. E. DOLBEAR, College Hill, H. A. ROWLAND, Baltimore.

To Nominating Committee: T. F. JEWELL, Newport.

Sectional Subcommittee: N. D. C. HODGES, Salem, J. B. MURDOCK, Annapolis, S. H. BRACKETT, St. Johnsbury.

Section adjourned to meet at 4 P. M., when Vice President MENDENHALL delivered his address.

Digitized by Google

SECTION C. *Chemistry.*

Section called to order by Vice President H. C. BOLTON of Hartford, ALFRED SPRINGER of Cincinnati, Secretary.

Fellow elected to Standing Committee: S. A. LATTIMORE, Rochester.

Sectional Committee: G. C. CALDWELL, Ithaca, E. W. MORLEY, Hudson, R. C. KEDZIE, Lansing.

To Nominating Committee: G. C. CALDWELL, Ithaca.

Sectional Subcommittee: A. A. JULIEN, New York, P. SCHWEITZER, Columbia, A. R. LEEDS, Hoboken.

Section adjourned to meet at 2.30 P. M., when Vice President BOLTON delivered his address.

SECTION D. *Mechanical Science.*

Section called to order by Vice President W. P. TROWBRIDGE of New Haven. In the absence of the Secretary, C. B. DUDLEY, J. BURKITT WEBB of Ithaca was elected to fill the vacancy. The other elections were deferred until the following day.

Section adjourned to meet at 4 P. M., when Vice President TROWBRIDGE delivered his address.

SECTION E. *Geology and Geography.*

This Section was called to order by Vice President E. T. COX of San Francisco. In the absence of the Secretary, C. E. DUTTON, the Section elected H. S. WILLIAMS of Ithaca to act in his place.

Fellow elected to Standing Committee: G. H. COOK, New Brunswick.

Sectional Committee: C. H. HITCHCOCK, Hanover, N. H. WINCHELL, Minneapolis, E. T. NELSON, Delaware.

To Nominating Committee: J. W. SPENCER, Paxton.

Sectional Subcommittee: P. W. SHEAFER, Pottsville, ALEX. WINCHELL, Ann Arbor, WILLIAM LILLY, Mauch Chunk.

Section adjourned to meet at 4 P. M., when Vice President COX addressed the Section, and an interesting discussion followed.

SECTION F. *Biology.*

Section called to order by Vice President DALL of Washington. In the absence of the Secretary, C. S. MINOT, WILLIAM OSLER of Montreal was elected to fill the vacancy.

Fellow elected to Standing Committee: A. J. COOK, Lansing.

Sectional Committee: J. A. LINTNER, Albany, W. J. BEAL, Lansing, H. F. BASSETT, Waterbury.

To Nominating Committee: L. F. WARD, Washington.

Sectional Subcommittee: THOS. MEEHAN, Germantown, B. D. HALSTED, New York, T. J. BURRILL, Champaign.

Section adjourned to meet at 4 P. M., when Vice President DALL delivered his address.

SECTION G. *Histology and Microscopy.*

Section called to order by Vice President A. H. TUTTLE of Columbus, ROBERT BROWN, jr., of New Haven, Secretary.

Digitized by Google

Fellow elected to Standing Committee: R. H. WARD, Troy.

Sectional Committee: A. B. HERVEY, Taunton, LOUIS ELSBERG, New York, R. HITCHCOCK, New York.

To Nominating Committee: J. D. HYATT, Morrisania.

Sectional Subcommittee: G. O. MITCHELL, Hanover, T. J. BURRILL, Champaign, C. C. MERRIMAN, Rochester.

Section adjourned to meet at 2.30 P. M., when Vice President TUTTLE delivered his address.

SECTION H. *Anthropology.*

In the absence of the Vice President, DANIEL WILSON of Toronto, the Secretary, OTIS T. MASON of Washington, called the Section to order.

Fellow elected to Standing Committee: P. R. HOY, Racine.

Sectional Committee: A. S. BICKMORE, New York, GARRICK MALLERY, Washington, N. S. TOWNSHEND, Columbus.

To Nominating Committee: HORATIO HALE, Clinton.

Sectional Subcommittee: J. O. DORSEY, Washington, GEO. H. PERKINS, Burlington, JOSEPH ANDERSON, Waterbury.

Section adjourned to meet at 4 P. M., when the address of Vice President WILSON was read by the Secretary, OTIS T. MASON.

SECTION I. *Economic Science and Statistics.*

Section called to order by Vice President E. B. ELLIOT of Washington, F. B. HOUGH of Lowville, Secretary.

Fellow elected to Standing Committee: JOSEPH CUMMINGS, Evanston.

Sectional Committee: J. R. DODGE, Washington, CHAS. W. SMILEY, Washington, E. B. WHITMAN, Cambridge.

To Nominating Committee: ELI E. TAPPAN, Gambier.

Section adjourned to 2.30 P. M., when Vice President ELLIOTT addressed the Section.

In the evening a General Session of the Association was held in the Queen's Hall, for the purpose of hearing the address of the retiring President of the Association, Prof. GEORGE J. BRUSH of Yale College, New Haven. President DAWSON introduced Professor BRUSH, who then delivered his address, after which the members were invited to repair to the assembly rooms adjoining, where a kind reception awaited them by the Local Committee represented by Dr. T. STERRY HUNT. Music was provided, and the rooms were handsomely decorated with flowering-plants, palms and ferns, while at one end of the main hall refreshment tables were placed, and several hours were passed in pleasant social intercourse.

THURSDAY, AUGUST 24.

The Association met in General Session at 10 A. M., in the William Molson Hall, President DAWSON in the chair.

The PERMANENT SECRETARY announced that an invitation had been extended to the members of the Association, by the directors of the MONTREAL AMATEUR ATHLETIC ASSOCIATION to visit their rooms and library.

Digitized by Google

The GENERAL SECRETARY read the list of names of sixty-one persons recommended for membership by the Standing Committee, making two hundred and thirty in all. On motion, the Secretary was directed to cast an affirmative ballot, and they were declared elected.

The Association then adjourned to meet in Sections. [The papers read before the several Sections are given in other parts of this volume.]

In Section A, a magnificent series of astronomical plates, from drawings by Mr. E. L. TROUVELOT, was placed on exhibition.

In Section C, the Chairman announced that, in accordance with the resolutions passed at the previous day's session, he had appointed a committee consisting of F. W. CLARKE, ARTHUR H. ELLIOTT and H. B. NASON, to discuss the feasibility of framing a list of chemical indices. He said their duty would be the discussion of one of the most important obstacles now in the way of chemistry. There being no uniform system of chemical indices, each chemist adopted a system of his own in recording the results of his investigations. When an eminent chemist chanced to die, the results of his life's experience and researches would follow him into his grave, and humanity would be deprived, perhaps, of the inestimable work of a life devoted to this science.

In Section D, DE VOLSON WOOD, of Hoboken, was elected to the Standing Committee, and G. LANZA of Boston, to the Nominating Committee.

In Section G, an invitation was read and accepted from the MONTREAL MICROSCOPICAL CLUB for Monday evening, from 8 to 10 P. M., for the practical demonstration of various modes of illumination.

In the evening the members were invited to the formal opening of the Redpath Museum, when the fine new building was presented by Mr. PETER REDPATH to the McGill University. After the ceremonies of presentation were over, Principal and Mrs. DAWSON held a reception in the Museum halls, to which the members of the Association and many citizens had been invited. During the evening Mr. Hovey's paper on "Cave Scenery" was given in the theatre, illustrated by lantern pictures.

FRIDAY, AUGUST 25.

The Association met in General Session at 10 A. M., President DAWSON in the chair.

The GENERAL SECRETARY read the names of fifty-two persons recommended by the STANDING COMMITTEE for membership in the Association, all of whom were duly elected. He also announced that the STANDING COMMITTEE had nominated Prof. W. A. ROGERS of Cambridge as Vice President for Section A, and Prof. ALEX. WINCHELL of Ann Arbor for Section H, and on motion the nominations were confirmed.

The STANDING COMMITTEE recommended that a committee be appointed to confer with committees of foreign associations for the advancement of

Digitized by Google

science, with reference to an international convention of scientific associations, the said committee to consist of T. STERRY HUNT, Montreal, ALEX. AGASSIZ, of Cambridge, Mass., and SIMON NEWCOMB, of Washington.

Also, that a committee be appointed to confer with a committee of the British Association on the annual records of science, said committee to consist of J. W. DAWSON, Montreal, F. W. CLARKE, Cincinnati, EDW. S. DANA, New Haven, H. W. MARTIN, Baltimore, and C. A. WHITE, Washington. Both these recommendations were adopted, and the committees appointed.

The following resolution was then proposed and adopted. Moved by Major JED. HOTCHKISS of Virginia, seconded by Prof. C. H. HITCHCOCK of Hanover, N. H.:—

Recognizing the relations of the late Prof. WM. B. ROGERS to this Association as one of its founders, his eminent and long continued services in the interest of science, and his world-wide reputation as a scientist, be it resolved, that the STANDING COMMITTEE of this Association be requested to appoint some member familiar with the life and labors of Professor ROGERS to prepare and read at the next annual meeting of this Association a suitable memoir of him, to be subsequently published in the Proceedings.

The Association then resolved itself into a meeting of Section B to listen to a paper "Upon the electrical experiments to determine the location of the bullet in the body of the late President Garfield, and upon a successful form of Inductive Balance for the painless detection of metallic masses embedded in the human body," by ALEX. GRAHAM BELL; it being understood that the other Sections would suspend their meetings until after the reading of this paper. At the conclusion of this interesting communication the thanks of the members were unanimously tendered to Professor BELL for his efforts in the cause of suffering humanity.

In Section C, the Index Committee reported the following resolution which was adopted:

Resolved, That a committee of five be appointed to *devise* and *inaugurate* a plan for the proper indexing of the literature of the chemical elements. Said committee to consist of the Chairman of the Section and four others to be appointed by him. The committee shall have full power to secure the coöperation of volunteers and be required to report at the meeting of the chemical Section in 1883.

F. W. CLARKE,
A. H. ELLIOTT,
H. B. NASON.

In Section I, Dr. HOUGH being obliged to leave for home, J. R. DODGE of Washington was elected Secretary of the Section.

Digitized by Google

On Friday afternoon a reception was given to the members by Mr. and Mrs. J. H. R. MOLSON in their house and grounds at Piedmont from 4 to 7 o'clock.

In consequence of the excursions to Quebec and Ottawa, there were no meetings of the Association on Saturday. Those who joined the Quebec excursion left by boat on Friday night, reaching Quebec early on Saturday morning, when, after breakfast on board the steamer, they were conducted by a Committee of citizens to visit the fortifications, the Citadel and the University. After this they embarked on another steamer for an excursion around the harbor, during which an excellent lunch was served on board, and was followed by addresses. The party returned to Montreal on Saturday evening by the North Shore Railway.

The Ottawa party left by early train on Saturday morning and reached the capital after a pleasant ride of four hours where they were met by the reception committee and conveyed to the various points of interest, after which luncheon was provided in the Drill Hall, accompanied by addresses of welcome and suitable responses by the members. The party returned to Montreal about midnight much pleased with the generous treatment they had received from the citizens of Ottawa. The excursion to Ottawa was conducted by Dr. J. W. DAWSON, and that to Quebec by Dr. T. STERRY HUNT.

MONDAY, AUGUST 28.

The Association convened in General Session at 10 A. M., the PRESIDENT in the chair.

The GENERAL SECRETARY read a list of seventeen persons recommended by the STANDING COMMITTEE for membership in the Association, and they were duly elected.

The special committee on the proposed memorial to CHARLES DARWIN, reported as follows:—

Whereas a committee has been designated to coöperate with the English Committee for collecting subscriptions for a memorial to CHARLES DARWIN, of which American Committee Mr. ALEXANDER AGASSIZ is Treasurer: the STANDING COMMITTEE of the American Association for the Advancement of Science, confident that all American Naturalists, and all friends of science, will be glad to join in the furtherance of this object, hereby commend it to the Association, and request that all members of the Association and all others who desire to do honor to the memory of a noble character, a most sagacious investigator, and a single-hearted lover of knowledge for its own sake, should send any contributions they may wish to make, directly to Mr. ALEXANDER AGASSIZ, at Cambridge, Mass.

The Committee to memorialize the Legislature of New York for a new survey of Niagara Falls asked for further time, which was granted.

Digitized by Google

The Committee to obtain permanent funds for the Association and to advise with the Treasurer and Permanent Secretary on financial matters, was discharged.

The Committee on the best methods of science teaching in the public schools reported that they had no report to present this year, but the STANDING COMMITTEE desired that it should be continued. The Association agreed to this.

Prof. GEORGE J. BRUSH, of New Haven, reported on behalf of the Committee appointed to coöperate with the Committee of the American Philological Association in relation to the proper restriction of the degree of Ph. D. He explained that the degree of Ph. D., which it was first intended should be given only by examination, had been given very largely throughout the country as an Honorary Degree, and the JOINT COMMITTEE resolved to address a circular to the various colleges, representing these facts and asking them to restrict the conferring of the degree. This was accordingly done, the circular being prepared and sent to some 415 colleges throughout the country. He asked that the Committee be now discharged as it had fulfilled the duty for which it was appointed. The Association agreed to this and the Committee was discharged.

The Committee on State Geological Surveys reported progress, and desired to be continued. As this was recommended by the STANDING COMMITTEE, it was agreed to by the Association.

The Committee on Standard Time reported progress and asked for further time to complete their work. The STANDING COMMITTEE recommended that the request be granted, and this was agreed to.

The PRESIDENT announced that Dr. Elliott, who was not present, was to have reported on behalf of the Committee on Weights, Measures and Coinage, and also for the Committee on Registrations of Deaths, Births and Marriages. The STANDING COMMITTEE has recommended that these committees be continued. The Association agreed to their continuation.

The PERMANENT SECRETARY made a number of formal announcements, and the Association then adjourned to meet immediately afterwards in the various sections.

Section D having finished the reading of papers assigned to it concluded its sessions in the afternoon.

In the afternoon a garden party was given to the members of the Association by Mr. and Mrs. L. J. SARGEANT at their residence, Weredale, at the western end of Dorchester street.

In the evening at 8 o'clock, a lecture was delivered before a large audience, by Prof. A. MELVILLE BELL, of Kingston, Ont., at the Queen's Hall, on the subject, "Visible Speech."

A number of the members interested in Microscopy attended the meeting of the MICROSCOPIC CLUB held in the rooms of the Natural History Society. The numerous microscopes belonging to the members were in

Digitized by Google

use. At 9.30 the gathering was called to order by Mr. JAMES FERRIER, jr. Dr. CARPENTER was introduced, and in the course of a very interesting address spoke of and explained several microscopes which he had brought with him from England, and also explained certain objects as viewed under them.

There was also a large attendance at the ART ASSOCIATION conversazione and at the GYMNASTIC ENTERTAINMENT both held at the same time.

TUESDAY, AUGUST 29.

The Association met in General Session at 10 A. M., President DAWSON in the chair.

The GENERAL SECRETARY read the names of fifteen persons recommended by the STANDING COMMITTEE for membership in the Association, and on motion they were duly elected.

The STANDING COMMITTEE recommended that Prof. G. F. BARKER of Philadelphia be appointed to prepare a memorial of the late Prof. W. B. ROGERS; also that the following be appointed a committee on indexing chemical literature: Profs. H. C. BOLTON, Hartford, IRA REMSEN, Baltimore, F. W. CLARKE, Cincinnati, A. A. JULIEN, New York, A. R. LEEDS, Hoboken, both of which recommendations were adopted.

The GENERAL SECRETARY then announced that the time had arrived when the important business of selecting a place for the next year's meeting was to be settled and read the following invitations:

MINNEAPOLIS, MINN., AUGUST 15, 1882.

At a special meeting of the Minnesota Academy of Natural Sciences held this evening, the following resolution was carried:

Resolved, That the Minnesota Academy of Natural Sciences hereby cordially renew the invitation tendered the American Association for the Advancement of Science in the year 1881, to meet in this city in 1882; and hereby assure the Association in repeating for the coming year, 1883, that invitation seconded by the city and its various institutions, that its members will receive at the hands of our people the same generous hospitality promised them at that time.

It was further moved and carried that Prof. N. H. WINCHELL, a member of this Academy, be instructed to present the above resolution to the Association.

A. F. ELLIOTT, *President.*
C. W. HALL, *Secretary.*

IOWA AGRICULTURAL COLLEGE,
AMES, AUG. 19, 1882.

TO THE NOMINATING COMMITTEE OF THE A. A. A. S.,

GENTLEMEN:—In behalf of the scientific men of this College and State, I would urge upon you the desirability of selecting a western place of meeting for the Association in 1883. We will give you most cordial wel-

Digitized by Google

come. We hope that you will decide to meet in Minneapolis, where you will receive royal treatment.

Very truly,

C. E. BESSEY,

Vice President of the Iowa Agricultural College, and President of the Iowa Academy of Sciences.

The Secretary announced that the Association had also received several other invitations, which were of an informal character, and that the STANDING COMMITTEE had decided to recommend the acceptance of the invitation from Minneapolis.

The President, Dr. DAWSON, said that the STANDING COMMITTEE had given the matter every consideration, and they had been unanimous in their verdict. Prof. N. H. WINCHELL had attended their meeting and his description of the city and the facilities it would offer had given the committee every satisfaction.

It was voted unanimously to hold the next annual meeting at Minneapolis, Wednesday, August 15, 1883.

The GENERAL SECRETARY then read the following list of members recommended by the STANDING COMMITTEE to be elected Fellows of the Association.

Allen, Harrison, Philadelphia, Pa.
Alvord, Henry E., Easthampton, Mass.
Ashburner, Wm., San Francisco, Cal.
Atwater, W. O., Middletown, Ct.
Baker, Marcus, Washington, D. C.
Bartlett, J. R., Washington, D. C.
Blair, Henry W., Washington, D. C.
Borden, Spencer, Fall River, Mass.
Britton, N. L., New Dorp, N. Y.
Burrill, T. J., Champaign, Ill.
Call, R. Ellsworth, Des Moines, Ia.
Chamberlain, Wm. J., Columbus, O.
Chance, H. Martyn, Philadelphia, Pa.
Chandler, Seth C., jr., Cambridge, Mass.
Chester, Albert H., Clinton, N. Y.
Chittenden, Russell H., New Haven, Conn.
Claypole, Edw. W., Yellow Springs, O.
Collier, Peter, Washington, D. C.
Comstock, J. Henry, Ithaca, N. Y.
Dabney, Chas. W., jr., Raleigh, N. C.
Dolbear, A. E., College Hill, Mass.
DuBois, Aug. J., New Haven, Ct.
Dudley, Chas. B., Altoona, Pa.
Dwight, Wm. B., Poughkeepsie, N. Y.
Edwards, Wm. H., Coalburg, W. Va.

Digitized by Google

Flint, James M., Boston, Mass.
Frazier, B. W., Bethlehem, Pa.
Fuller, A. S., Ridgewood, N. J.
Gatschet, A. S., Washington, D. C.
Hale, Horatio, Clinton, Ont.
Hazen, W. B., Washington, D. C.
Hines, Chas. F., Carlisle, Pa.
Hodges, N. D. C., Salem, Mass.
James, Jos. F., Cincinnati, O.
Jewell, Theo. F., Newport, R. I.
Kendall, E. Otis, Philadelphia, Pa.
Kennan, George, Washington, D. C.
Langdon, F. W., Cincinnati, O.
Lanza, Gaetano, Boston, Mass.
Lazenby, Wm. R., Columbus, O.
Lilly, William, Mauch Chunk, Pa.
Love, Edw. G., New York, N. Y.
Macfarlane, James, Towanda, Pa.
Macloskie, George, Princeton, N. J.
McGee, W. J., Farley, Iowa.
McNair, A. R., Saratoga Springs, N. Y.
Mixter, Wm. G., New Haven, Ct.
Neale, Arthur T., New Brunswick, N. J
Nelson, A. B., Danville, Ky.
Peirce, C. S., Baltimore, Md.
Penhallow, D. P., Mountainville, N. Y.
Perkins, George H., Burlington, Vt.
Pilling, James C., Washington, D. C.
Platt, Franklin, Philadelphia, Pa.
Prentiss, D. Webster, Washington, D. C.
Reed, E. B , London, Ont.
Rockwell, A. P., Boston, Mass.
Ross, Waldo O., Boston, Mass.
Roland, Henry A., Baltimore, Md.
Russell, J. C., Salt Lake City, Utah.
Schanck, J. Stillwell, Princeton, N. J.
Seiler, Carl, Philadelphia, Pa.
Sestini, B., Woodstock, Md.
Sigsbee, Chas. B., Washington, D. C.
Smith, Edwin, Washington, D. C.
Snyder, Monroe B., Philadelphia, Pa.
Spencer, Jas. Wm., Windsor, N. S.
Stallo, J. B., Cincinnati, O.
Stevens, W. Leconte, New York, N. Y.
Stone, George H., Colorado Springs, Col.
Sturtevant, E. Lewis, South Framingham, Mass.
Swift, Lewis, Rochester, N. Y.

Digitized by Google

Taylor, Arthur F., Cleveland, O.
Thomas, Benj. F., Columbia, Mo.
Thomas, Cyrus, Carbondale, Ill.
True, Fred. W., Washington, D. C.
Trumbull, J. H., Hartford, Conn.
Van Dyck, Francis C., New Brunswick, N. J.
Walcott, Chas. D., Washington, D. C.
Wallace, William, Ansonia, Conn.
Warren, Cyrus M., Brookline, Mass.
Webster, H. E., Schenectady, N. Y.
Wharton, Joseph, Philadelphia, Pa.
Wheeler, Orlando B., Detroit, Mich.
White, I. C., Morgantown, W. Va.
Williams, H. S., Ithaca, N. Y.
Winsor, Justin, Cambridge, Mass.
Wright, Geo. F., Oberlin, Ohio.
Zentmayer, Joseph, Philadelphia, Pa.

These were balloted for and all duly elected.

The PERMANENT SECRETARY announced that the Standing Committee had decided to publish the papers read before the various Sections by title or abstract, unless a special recommendation should come from the Sections in relation to particular papers.

The Association then adjourned to meet in Sections.

Sections A, B, C, F and G finished the papers before them, and adjourned in the afternoon.

In the evening the members of the Association with a large number of citizens of Montreal met in the Queen's Hall to hear the lecture on THE TEMPERATURE OF THE DEEP SEA, by Dr. WILLIAM B. CARPENTER of London. President DAWSON was in the chair, and the officers of the Association with distinguished guests occupied the platform.

The PRESIDENT briefly introduced the lecturer, who on coming forward was greeted with applause.

Dr. CARPENTER, after some introductory remarks, said that the North Polar region was probably sea and covered with ice; while the South Polar region was probably land, or rather a group of islands covered with an ice-sheet extending out to sea and forming the great Antarctic barrier. If the whole area of the globe was divided into fifteen parts, it would be found that the land-surface covered only four, while the sea-surface covered eleven; or in other words the Land-surface was to the Sea-surface as four to eleven. But the proportion is very different when the mass of the water below the sea-level is compared with the mass of the land above it. If the whole land were levelled down to a uniform height, it would barely rise on an average a thousand feet above the sea-level. The average depth of the great ocean basins was however some 12,000 or 13,000 feet. Working out these figures, it would be found that the mass of the Land

Digitized by Google

was to the mass of the Sea as 1 to 36; or, in other words, the mass of the Sea *beneath* the sea-level was 36 times as much as the mass of the Land *above* the sea-level. Until very recent times, the speaker said, much difficulty had been experienced in ascertaining the temperature of this deep sea mass. Many observations had been made of bottom-temperature; but these were mainly local, and in many cases fallacious on account of the instruments employed. It has been found that at the enormous pressure to which they are subjected, the bulbs of the thermometers are compressed, and the mercury forced up into the tube; incorrect results being thus obtained. In 1868 he obtained from the British Admiralty the use of a vessel for carrying down dredging explorations to a greater depth than had been previously attempted; and being provided with the best deep-sea thermometers then made, he chanced, in using them, to stumble upon a most remarkable fact. A course had been shaped for the deepest water to be found near Great Britain; and a depth of more than 500 fathoms, or 3,000 feet, was obtained near the Faroe Islands. The thermometers were let down; and to his great surprise it was found that they fell to below 32 degrees. The doctrine among Physical Geographers at that time, was that the universal deep sea-temperature was about 39 degrees, which they considered to be the greatest density of sea water. At the same depth, within twenty miles of the same spot, a temperature of 45 degrees, 13 degrees higher, was found. This strange result excited his interest, as he considered that it had a most important bearing on fundamental questions of Physical Geography and Geology. He brought his results home, and urged upon the Admiralty the importance of ascertaining what effect different pressures would have upon the best-constructed thermometers. This was ascertained by the hydrostatic press; and it was found that at the pressure of three tons on the square inch (which was what their bulbs would have to sustain at a depth of about 2,400 fathoms) the thermometers went up from 10 to 20 degrees,—showing the fallacy of all past observations on deep-sea temperature. Half a ton pressure was found to send the instrument up some 2½ degrees; and from this he concluded that the temperature of 32 degrees which they had found was in reality 29½°. The next thing was to devise means by which this pressure on the thermometer could be obviated. This was done, at the suggestion of the late Prof. W. A. Miller, by simply enclosing the bulb of the thermometer in another bulb with some fluid between, but also including a vacuum; so that a slight reduction in the capacity of the outer bulb did not affect the real thermometer bulb. In all further observations these instruments were used, and gave the true temperatures. The result of these observations was, that the doctrine that 39 degrees was the general temperature of the deep sea was shown to be a fallacy; and it proved to have been propounded in ignorance of the fact long previously determined by the careful experiments of Despretz, that *sea*-water (unlike fresh water) continues to contract in cooling, down to its freezing-point at or under 28° Fahr. He was so much struck with his experience in the Faroe Channel, that he soon afterwards obtained another

Digitized by Google

steamer, and took observations with the new thermometers; when the real temperature of the cold area was found to be 29½ degrees, as they had expected. The bottom temperature of the North Atlantic, on the other hand was uniformly 35° Fahr. The cause of this was, that while the Faroe channel is an extension of the Arctic basin, the coldest Polar water cannot find its way into the basin of the North Atlantic, being kept back by ridges extending across the channels between Greenland and Iceland, and between Iceland and the Faroes.—The observations were carried down through the Bay of Biscay in 1870, and into the Mediterranean Sea. From all these observations the important conclusion was drawn, that the bottom-temperature of the deep sea is not determined by the latitude, but by the freedom of communication with either of the great Polar areas, permitting a vast underflow of Polar water towards the Equator, with a corresponding slow movement of the upper stratum from the Equator toward the Poles.

The lecturer then referred briefly to the subject of the Gulf Stream. This subject, he said, possesses much interest to persons on either side of the Atlantic. An enthusiastic American had asserted that America, by cutting a channel through the Isthmus of Panama, could entirely divert the Gulf Stream, and turn Great Britain into a howling wilderness. (Laughter.) The speaker assured the audience that this was no joke of his own, but had actually been propounded. But he thought he could show that there was not much truth in such a statement; and proceeded to explain what (in his view) the Gulf Stream does, and what it does not. The temperature of Great Britain is affected by a surface-flow of warm water flowing in a northeasterly direction. This serves to keep open all the harbors of Norway the most part of the winter, and was certainly of the greatest importance. Now, all marine surveyors had come to the conclusion that the Gulf Stream dies out as a current in the middle of the Atlantic; and that the remaining flow is mere surface-drift produced by the prevalence of southwesterly winds, which carries it northeast. It is demonstrable that in this passage any stratum of only 100 fathoms thickness (and the spread-out Gulf Stream current cannot certainly be deeper than this) would soon take the temperature of the air above it, so as to lose its special heating power. But the Challenger temperature-sections have shown that the Gulf Stream carries into mid-Atlantic an enormous body of warm water; which, in virtue of the higher specific gravity it derives from concentration, there sinks down, displacing colder water and thus makes the mid-Atlantic a storehouse of heat. The question then arises, How does this water get further? The speaker explained that this warm water is carried northeast by the general oceanic circulation, which brings to the British and Norwegian shores a stratum of warm water 500 fathoms deep, deposited as it were for their use in the mid-Atlantic. If they had not this General Circulation, the Gulf Stream would never come near their shores. If they had not the Gulf Stream, the General Circulation would do much less towards their warmth.—The speaker illustrated his remarks by numerous interesting diagrams.

Digitized by Google

At the close of the lecture, on motion of Professor JAMES HALL, a hearty vote of thanks was tendered to Dr. CARPENTER.

Afterwards a reception was given to the members of the Association by Mr. and Mrs. M. H. GAULT, in their beautiful grounds, which were brilliantly illuminated with Chinese lanterns, and handsomely decorated for the occasion. During the evening an admirable selection of music was rendered by Gruenwald's orchestra.

An "at home" was also given at the same time by Hon. Justice and Mrs. MACKAY.

WEDNESDAY, AUGUST 30.

The Association at 10 A. M. met in General Session in Molson Hall, President DAWSON in the chair.

The GENERAL SECRETARY read the names of ten persons recommended by the STANDING COMMITTEE for membership, all of whom were elected. This makes three hundred and twenty-five new members elected since the opening of the meeting in Montreal.

The STANDING COMMITTEE recommended the granting of the request from Section C, asking for a Committee to petition the Agricultural Department of the United States or Canada to print the paper on "Sources of nitrogen in the soil" by Messrs. LAWES and GILBERT, and the following Committee was appointed: GEORGE B. LORING, WILLIAM SAUNDERS, C. V. RILEY, E. B. ELLIOTT and O. T. MASON.

The STANDING COMMITTEE recommended the following amendment to ARTICLE VII of the Constitution.

"The Standing Committee shall also have power to exclude from the Association any member or fellow on satisfactory evidence that said member or fellow is an improper person to be connected with the Association, or has in their estimation made improper use of his membership or fellowship."

The consideration of this proposed amendment will take place at the next meeting.

Mr. ELLIOTT, Vice President of the Section of Economic Science and Statistics, presented the following report with the sanction of the Standing Committee:

"The Sectional Committee of the Section of Economic Science and Statistics, have considered the papers referred to them having reference to the Standard of Time, and recommend:

"First, That the Association should express its gratification at the passage of the joint resolution by the Congress of the United States, authorizing the President of the United States to call an international conference to fix on and recommend for universal adoption a common prime meridian, to be used in the reckoning of longitude and the regulation of time throughout the world.

"Second, They further recommend the appointment by the Association of a Committee to confer in such a manner as it may seem best with the

Digitized by Google

Convention named in the resolution of Congress, and also to represent this Association, as its delegates, in any other convention that may be called to consider the subject of the standard of time.

"It is understood that the important legislation on the part of Congress is due in no small measure to the earnest and well directed efforts of the American Meteorological Society and of the American Society of Civil Engineers. A communication from Mr. Sandford Fleming, representing the American Society of Civil Engineers, has been received by this Sectional Committee, and will be referred to the Committee which may be appointed.

"The following Committee on a primary meridian and an international standard of time is respectfully suggested, viz.: F. A. P. BARNARD, New York; C. A. YOUNG, Princeton; T. STERRY HUNT, Montreal; J. K. EASTMAN, Washington; CHARLES CARPMAEL, Toronto, and E. B. ELLIOTT, Washington.

The report was accepted and the designated committee appointed.

The PERMANENT SECRETARY then read the list of the officers proposed by the Nominating Committee for the next year, as follows:

President — C. A. YOUNG of Princeton, N. J.

Vice Presidents — Section A — W. A. ROGERS, Cambridge, Mass.; B — H. A. ROWLAND, Baltimore, Md.; C — EDWARD W. MORLEY, Cleveland, O.; D — DE VOLSON WOOD, Hoboken, N. J.; E — C. H. HITCHCOCK, Hanover, N. H.; F — W. J. BEALE, Lansing, Mich.; G — J. D. COX, Cincinnati, O.; H — O. T. MASON, Washington, D. C.; I — F. B. HOUGH, Lowville, N. Y.

General Secretary — J. R. EASTMAN of Washington, D. C.

Assistant General Secretary — ALFRED SPRINGER of Cincinnati, Ohio.

Secretaries of the Sections — Section A — W. W. JOHNSON, Annapolis, Md.; B — C. K. WEAD, Ann Arbor, Mich.; C — J. W. LANGLEY, Ann Arbor, Mich.; D — A. J. DUBOIS, New Haven, Conn.; E — ALEXIS A. JULIEN, New York, N. Y.; F — S. A. FORBES, Normal, Ill.; G — CARL SEILER, Philadelphia, Pa.; H — G. H. PERKINS, Burlington, Vt.; I — JOSEPH CUMMINGS, Evanston, Ill.

Treasurer — WM. LILLY of Mauch Chunk, Pa.

The whole list was elected amidst considerable enthusiasm.

Dr. T. STERRY HUNT made a statement in reference to the International Geological Committee, of which Professors HALL, SELWYN, LESLEY, and himself had been appointed representatives from North America. Several months ago a report was prepared by them. The work was not yet completed, and, on the recommendation of the STANDING COMMITTEE, he moved that the Committee be continued. The motion was seconded by Professor HALL, and the Committee was continued.

The PERMANENT SECRETARY made a number of announcements, and the PRESIDENT gave some particulars regarding the excursions for the day. The Session then adjourned to meet in Sections.

Digitized by Google

Sections E, H, and I finished their work, and finally adjourned at the close of the morning session.

In the afternoon the members were taken on an excursion around the harbor to the Victoria Bridge and to the Grand Trunk workshop, returning soon after six o'clock, well pleased with their trip.

At 8.30 P. M. the concluding General Session was held in the William Molson Hall, when there was a large attendance of the members of the Association and the citizens of Montreal.

President DAWSON said they had now arrived at the closing exercises of the meeting, and that he would call upon the Permanent Secretary, Professor PUTNAM, to make some remarks with reference to his latest work, the programme of the Association.

In reply, the PERMANENT SECRETARY stated that this was the largest meeting the Association had ever held, with the exception of that at Boston two years ago, when sixty more names were entered on the register. During the present meeting 937 names were recorded on the Association register. Of these, 20 were invited guests and their ladies, from England, Ireland, Hungary, Austria, France and Russia; 579 members and 338 representatives of families of members were in attendance from the following places: Montreal, 90, other parts of the Dominion of Canada, 44; New York, 199; Massachusetts, 158; Ohio, 74; District of Columbia, 60; Pennsylvania, 43; New Jersey, 38; Connecticut, 30; Illinois, 22; Missouri, 22; Michigan, 18; Vermont, 16; Maryland, 15; Rhode Island, 14; Maine, 13; New Hampshire, 12; Indiana, 10; Florida, 5; South Carolina, 4; Virginia, 4; Colorado, 3; Minnesota, 3; Nebraska, 3; California, 2; Tennessee, 2; Mississippi, 2; North Carolina, 2; Louisiana, 2; Wisconsin, 2; and Alabama, Kentucky, West Virginia, Kansas and Iowa, one each; total, 937. Three hundred and twenty-five new members had been elected besides the members of the Local Committee who wished to accept membership in the Association. Two hundred and fifty-four papers had been sent in, which, with the exception of twelve, had been called up in the nine sections, that had been in session during the greater part of the week, and nine addresses and two lectures had been delivered.

The following resolutions were passed unanimously:

Prof. E. D. COPE, of Philadelphia, moved the following resolution:—

That the Local Committee of the Association have won our heartfelt esteem for the admirable efficiency with which they have planned and carried out the arrangements for our comfort. Especial mention should be made of the beautiful and complete "Handbook to the City of Montreal," prepared for the occasion by Mr. S. E. DAWSON, which has been a constant guide to us all; of the labors of the Railway Committee, Lodging Committee, the Excursion Committee, the Finance Committee, the Printing Committee, and the Reception Committee.

In moving this resolution, Professor COPE enumerated the different duties performed by the various committees, and expressed the hope that

Digitized by Google

they had received some return for the great sacrifice which they had been called upon to make.

Dr. E. B. ELLIOTT, of Washington, moved the following:—

That the American Association for the Advancement of Science, deeply sensible of the kindness which they have received in Montreal, hereby declare their thanks to the hotels, the Diocesan Theological College and private citizens for hospitality, and to the ladies for the elegant garden parties and other courtesies extended to the members and their families.

In moving this resolution Dr. ELLIOTT said he wished that he felt able to move it in a fitting manner. His duties as Vice President of one of the Sections had occupied the most of his time, and he had not had much leisure to take advantage of many of these entertainments. He referred to the hospitality extended to the members of the Association in this city twenty-five years ago, which he had no doubt was prompted by their love of science, and said he felt that the newspapers of Montreal were educating the people to a high standard in this direction, and their example might be profitably followed even by some of the prominent newspapers of the United States. He concluded by referring to the very large accession of members which the Association had received at this meeting.

Professor COX moved the following resolution:—

That the American Association hereby extends its heartfelt thanks to the Corporation and Faculty of the McGill University, of the Presbyterian Theological College, and the Society of Natural History, for commodious quarters during the meeting, and for the consideration with which every want has been anticipated and gratified.

In offering this resolution Professor COX said he considered that it would be fully sustained by all the members. They had seldom been provided with more extensive, commodious or convenient rooms, and he was sure they would long remember the edifices of this University, its splendid library, museum and beautiful grounds.

Prof. WILLIAM SAUNDERS, of London, Ont., moved the following:—

That the thanks of the American Association are due and are most heartily tendered to the numerous railways of the United States and the Dominion, and to the several steamship companies, for their courtesy in affording members excellent facilities for attendance at this meeting. We especially acknowledge our obligations to the Grand Trunk Railway Company for the excursion to Lachine, and for the freedom of that monument of engineering skill, the Victoria Bridge. We also thank the Harbor Commissioners for the excursion of to-day.

Prof. Saunders in his remarks said that the subject of transportation was in one sense a dull one, and had nothing very transporting about it. The Companies had so carefully conducted their arrangements that the baggage as well as the persons of members had been well cared for.

Digitized by Google

Professor LEEDS moved the following resolution:—

That the cordial thanks of this Association are due and tendered to the Telegraph and Telephone Companies for their great liberality in extending the free use of their wires to the members and fellows during the meeting.

In offering this resolution, Prof. LEEDS said he did so with a full sense of the great obligation they were under to these companies for the aid they had given. But as the Association for the Advancement of Science he thought these companies in their turn owed them something, as it had been the mother of electricity, and one of its members shared with Morse the honor of the discovery of the electric telegraph,—Joseph Henry. (Applause.) And since that time the Association had given much thought and care to the subject of electricity, as evinced by the valuable contributions from Edison and other great electricians, and the recent valuable lecture by Prof. Alex. Graham Bell. He, therefore, thought they could say that the privileges granted by the companies were in one sense a due concession to science.

Professor PUTNAM remarked that for two months previous to the meeting the telegraph company had given free transmission of messages to himself and the Secretary of the Local Committee in Montreal.

Dr. T. STERRY HUNT, of Montreal, moved:

That the members of the Association and their families will ever hold in grateful remembrance the generosity of the Richelieu & Ontario Navigation Company and of the North Shore Railway for the delightful excursions to Quebec, and the Mayor, Local Committee and citizens of that deeply interesting spot, for the harbor excursion and the bounteous collation provided for the enjoyment of their guests.

The mover referred to the incidents of the trip and the pleasure enjoyed by all those who attended the visit to Dufferin Terrace, to the ancient Citadel, Laval University, the Harbor, etc. He considered that all those who attended the excursion would need have nothing said to them to make them support the resolution. He called upon Dr. HINGSTON, as Chairman of the Conveyance Committee, to add a few words of thanks to the railway and steamboat authorities.

Dr. HINGSTON made a few remarks, in the course of which he said that the President, Dr. HUNT and himself were surviving members of the Local Committee who entertained the Association in this city twenty-five years ago. If Darwin or any of his disciples were present he would say it was another illustration of the survival of the fittest. (Laughter.) He expressed their thanks to the railway authorities for the readiness with which they had responded to their appeals, and did everything in their power to add to the comfort and convenience of the members of the Association.

The PRESIDENT, Dr. DAWSON, remarked that the members of the Association felt very much indebted to the citizens of Quebec for the aid they had given in making this meeting an agreeable one.

Digitized by Google

Dr. JOHN RAE moved the following resolution:—

That the thanks of the Association are most cordially tendered to the Canadian Pacific Railway for the special train to Ottawa, and to the Mayor, Local Committee and citizens of Ottawa, for the delightful view of the natural beauties, industries and public buildings of the place, for their elegant repast and for their kind words they were pleased to bestow upon the Association.

Dr. RAE said that all those who went to Ottawa and saw its beautiful buildings would agree with him that it was one of the most charming days they spent. He spoke of the beauty of the Parliament buildings, and the universal admiration with which they were regarded.

Prof. JAMES HALL, in supporting the motion, said that no one who had seen the library of Parliament at Ottawa could fail to express their admiration. It had no equal in the United States. The Museum at Ottawa was also a valuable institution, and it must always be the resort of scientific men. For this reason they should foster it. He, the speaker, had advocated the holding of the first meeting of the Association at Montreal twenty-five years ago, and had been largely instrumental in having it held here. He had many pleasant reminiscences of that meeting, and would always remember Montreal.

The Rev. Dr. HOVEY moved the following:

That the thanks of the American Association are due to the gentlemen of the local press, and the agents of papers in other cities, for the untiring pains which they have taken in reporting the proceedings of the Montreal meeting.

In moving this resolution, Dr. HOVEY said if it were not for the gentlemen of the press the deliberations of the members would not be so widely known as they are. He enumerated the various city papers to which they were indebted, as well as those of Boston, New York and Chicago, and also added that the proceedings of the Montreal meeting were, he considered, better reported than any previous one.

Dr. HAUGHTON of Dublin offered the following:

The American Association is especially honored at this Montreal meeting by the presence of so large a number of eminent visitors from abroad, thereby conferring an international character upon this assemblage on Canadian soil.

He said that a task had been assigned to him which no one but an Irishman could perform. He had been required to propose a vote of thanks to himself and then respond to it. (Laughter.) After returning thanks on behalf of the visitors for the courtesies extended to them by the Association, he said the only way in which he could express his opinion of the hospitality of which they had been the recipients, was by saying that if his mother had not been an Irishwoman he could have wished she had been a Canadian. [Applause.]

Digitized by Google

Prof. O. T. MASON, with a few humorous remarks, moved:

That a vote of thanks be returned to the Southeastern Railway Company for the contemplated excursion to Newport and Lake Memphremagog.

Dr. ALEX. WINCHELL moved:

That the thanks of the Association be given to the officers of McGill University, Mechanics' Institute, Art Association, Natural History Society, the Montreal and Amateur Athletic Association, Numismatic Society, Young Men's Christian Association, and the Merchants' Exchange for invitations extended to members of the Association.

Dr. WINCHELL, in moving it, spoke in high terms of the Art Gallery and the Peter Redpath Museum, and the high educational value of such collections to the citizenship of the community at large.

After the passage of the several resolutions, President DAWSON brought the proceedings to a close with some observations in regard to the object of the gathering just brought to a termination. It was very gratifying, he said, to know that this has been one of the most successful meetings of the Association, not only in regard to attendance, but in respect to the papers read and the practical benefits which might be expected to follow. He hoped all would carry away something which would make them wiser and better. He also hoped that they would carry away with them pleasant memories and a stimulus and encouragement which would lead them to greater achievements in the future.

The meeting then adjourned to meet at Minneapolis on the third Wednesday in August in next year.

ON THURSDAY MORNING

A party of nearly four hundred, composed of members and their ladies, availed themselves of the liberality of the SOUTHEASTERN RAILWAY and took part in the complimentary excursion to the little town of Newport and the picturesque lake Memphremagog. The weather was propitious and the party reached their destination at 12.30, where after partaking of an excellent dinner they embarked on the steamer "Lady of the Lake," and enjoyed a magnificent sail of about seventeen miles up, passing many points of interest and returning to Newport in time to take the 5.15 train to Montreal where the members finally separated.

WM. SAUNDERS,
General Secretary.

Digitized by Google

REPORT OF THE PERMANENT SECRETARY.

By holding a meeting for the second time beyond the limits of the United States, the Association has shown that its name of American is to be received in the widest sense.

A quarter of a century ago its eleventh meeting was held in Montreal, and again it was welcomed to the city for its thirty-first. In 1857 there were 351 names entered on the register of persons in attendance, and about 250 new members were elected; in 1882 there were 937 names registered and over 300 new members were elected. In 1857, 118 papers were read before two sections and one subsection, the regular presidential address and two memorial addresses were delivered; in 1882, 242 papers were presented before nine sections, and in addition to the presidential address there were seven by vice-presidents, also one special address and two evening lectures. In the volume of the proceedings relating to the eleventh meeting there are given the names of 946 members; in the present volume there are 1922. These few comparative statements show the growth of the Association in twenty-five years, and in this connection it must be remembered that during the civil war the meetings were suspended for five years.

Of the 255 papers entered on the list of titles received, one came after section D, to which it belonged, had adjourned; three were withdrawn by their authors, and eight were declined for various reasons. The paper by Mr. Meehan was given as an address before the biological section in accordance with the vote of the former section B at the Cincinnati meeting, and Mr. Hovey's paper on cave scenery was delivered in the theatre of the Redpath Museum on the evening of the formal opening of the Museum. Of the remaining 241 papers, 18 were referred to section A, 37 to B, 29 to C, 9 to D, 45 to E, 40 to F, 16 to G, 32 to H, and 15 to I.

The present volume contains the address delivered by Professor Hall, as retiring president of the Montreal meeting of 1857, now for the first time printed. The presidential address of Prof. Brush, and those of seven vice-presidents, the special address of Mr. Meehan, an abstract of Dr. Carpenter's lecture, and 124 papers either in full or by more or less extended abstracts as follows: Section A, 16; B, 13; C, 14; D, 7; E, 25; F, 25; G, 10; H, 10; I, 4. One hundred and seventeen other papers are mentioned by title simply, either from their authors failing to send abstracts for publications, or, in a few instances, in accordance with the votes of the standing committee that they should so appear. The delay in printing the volume has been due to a combination of causes for which neither the secretary nor the printers are responsible.

Of the 87 members elected fellows during the meeting, one has resigned his membership, one has declined, four have not yet answered the notices sent them, and 81 have accepted.

Of the new members elected, fifteen were invited foreign guests, twenty-two have declined, forty-eight have not yet been heard from, and 288 have paid in full, and their names are entered on the roll.

Seven members and fellows have become life-members since the report given in the Cincinnati volume.

For a statement relative to the 937 members and others registered at the meeting, I refer to the paragraph on page 635 of this volume.

Two thousand and fifteen copies of the Cincinnati volume of proceedings were received from the printers, and 1497 were sent to members entitled to receive them, 23 have been sold, and 177 distributed in accordance with votes of the Standing Committee. Of the preceding volumes, 77 have been sent to members entitled to them, 51 sold, and 19 have been distributed by vote of the Standing Committee. Four of the early volumes have been purchased and two have been received as a gift.

Digitized by Google

The Nashville volume was reprinted and stereotyped during the year, thanks to the liberality of General Lilly, and 253 copies were received from the printer. The St. Louis volume will be reprinted during the present year by the liberal gift of a member. After this is done there will be left on hand several hundred dollars which will be reserved for reprinting the second volume as soon as the required amount is secured.

Since the report given in the Cincinnati volume, under date of April 26, notices of the decease of 39 members and fellows have been received, among whom are three past-presidents, including the only Honorary Fellow of the Association; the former Treasurer, a former General Secretary, and four original members. Of these the names of thirty-two were read at Montreal and are recorded on pages 618–19 of this volume.

During the same period the names of 67 members and fellows have been taken from the list in consequence of resignations or from their being over two years in arrears in their assessments. In the same time 24 names have been restored to the list. Seven members elected at Cincinnati have accepted during the past year, in addition to the 319 mentioned in the last report.

The total number of members and fellows at the present date is 1920, a net gain of 221 since the list was printed in the Cincinnati volume.

For a statement of the receipts and expenses for the year covering the Cincinnati meeting and ending just previous to the Montreal meeting, I refer to the cash account on the following pages.

The invested funds of the Association are as follows:

General Fund, $84 67, int. to Aug. 1, '83, $4 23, . . .	$88 90	
Life Membership Fund, $1900 54, int. to Aug. 1, $73 00,	1973 54	
		$2062 45

The subscription fund for reprinting stands as follows:

June 10, 1881,	Gift of A. Schaffranck, ...	5 00	
Aug. 16, 1881,	Mrs. H. Herrman, ...	100 00	
	G. J. Brush, ...	20 00	
	William Bross, ...	20 00	
	William Lilly, ...	10 00	
	Thomas Meehan, ...	5 00	
	George Holley, ...	5 00	
	Robert Peters, ...	5 00	
	L. H. Trowbridge, ...	5 00	
	W. LeConte Stevens, ...	5 00	
	F. P. Dewey, ...	5 00	
	Alfred Springer, ...	5 00	
	J. D. Cox, ...	5 00	
	S. F. Peckham, ...	2 00	
	J. B. Killebrew, ...	2 00	
	F. W. Clarke, ...	2 00	
	W. H. Walmsley, ...	1 00	
	Several unknown contributors,	6 00	
April 10, 1882,	William Lilly, ...	1000 00	
July 3, 1882,	Geo. L. Vose, ...	1 00	
August 23, 1883,	A Member, ...	850 00	
Interest to Aug. 14, 1882,	. . . . .	8 16	
Interest to Aug. 1, 1883,	. . . . .	46 30	
			$2113 46
Cost of reprinting and stereotyping Nashville volume,		$857 94	
Balance on hand, ...		1255 52	
			$2113 46

Respectfully submitted to the Association,

F. W. PUTNAM, *Permanent Secretary.*

Salem, Mass., July 27, 1883.

Digitized by Google

F. W. PUTNAM, PERMANENT SECRETARY,

Dr. THE AMERICAN ASSOCIATION FOR

1881-2.

To Assessments previous to the 30th Meeting . .	$408 00		
" Cincinnati, " " . .	3,315 00		
" Montreal, 31st " . .	1,359 00		
			$5,082 00
Entrance fees Boston Meeting	15 00		
" " Cincinnati "	1,485 00		
" " Montreal "	330 00		
Fellowship fees	112 00		
			1,942 00
Sales of Publications and Binding	334 76		
Advertisements on covers	111 00		
Illustrations	3 00		
Postage 1.18; sale of old paper .55	1 73		
			450-49
Life Membership commutations (Intr. 6.00) .	256 00		
Reprinting fund, subscriptions (Intr. 8.16) .	212 16		
William Lilly, Patron	1,000 00		
			1,468 16
			$8,942 65

SALEM, MASS., AUGUST 15, 1882.

I have examined the above account and find

IN ACCOUNT WITH

THE ADVANCEMENT OF SCIENCE. Cr.

1881-2.

By 2015 copies Proceedings, Vol. 30, Cincinnati Meeting:—			
Composition, stereotyping, and boxes for plates	$1,129 40		
Illustrations	22 49		
Paper and press-work	921 40		
Covers	20 00		
Binding 1,962 in paper 470.88; 40 in cloth 20.00	490 88		
" 15 in half-morocco 15.00; 25 covers 5.00	20 00		
Printing wrappers and wrapping	18 00		
Distribution by mail and express	229 30		
Extras of Addresses and Reports	38 19		
			$2,889 66
Vol. 29, Illustrations 2.40; Addresses 9.50	11 90		
Distribution, balance of postage and express	120 17		
			132 07
Expenses of Cincinnati Meeting			488 96
Publications bought, and binding			57 62
Extras of Addresses Montreal volume			15 41
General expenses:—			
Rent of office to July 1, 1882	100 00		
Janitor to Aug. 1, 1882	102 00		
Fuel 40.50, Express 46.40	86 90		
Minor expenses, stationery, office furniture, etc.	25 45		
Subscription to Postal Guide	1 50		
Postage and envelopes 286.31, P. O. box 8.00	294 31		
Printing circulars, blanks, cards, etc.	260 76		
Extra clerk hire	33 25		
			904 17
Balance paid Perm. Sec'y, due last acct.			773 03
Salary of Assistant Secretary	400 00		
" " Permanent "	1,000 00		1,400 00
Life Membership Fund 250.00, Intr. 6.00	256 00		
Reprinting Fund, including 5.00 received in 1880	365 62		
" and stereotyping Vol. 26 (250 copies)	851 54		1,473 16
Balance to new account			808.57
			$8,942 65

the same correctly cast and properly vouched.

HENRY WHEATLAND, *Auditor.*

Digitized by Google

Digitized by Google

INDEX.

PAGE

Acids.....281, 282, 283
Act of Incorporation..... xxii
Address of Retiring President..... 1, 622
Address of Retiring President delivered in 1857..... 29
——— — Vice President, Section A..... 77
——— — — — ——— Section B..... 127
——— — — — ——— Section C..... 220
——— — — — ——— Section D..... 295
——— — — — ——— Section F..... 423
——— — — — ——— Section G..... 499
——— — — — ——— Section H..... 531
Aërial navigation..... 318
Agricultural statistics..... 599
Air and ocean, Currents of..... 367
Aletia xylina, Hibernation of..... 468
American continent, Geological history of..... 29
Amylose..... 285
Ancient customs, Unnoticed affinities..... 569
Andrews, L. W., Constitution of Benzole..... 286
Anemometer, Mean direction integrating..... 147
Archæological discoveries in Vermont..... 592
Art Association..... 618
Arteries, Morphology of..... 488
Athletic Association..... 622, 627
Ayres, Brown, Title of paper..... 226

Baker, Frank, Morphology of Arteries..... 488
——, T. R., Title of paper..... 321
Balloon, Future of as means of aërial travel..... 319
Baric hydrate, Action of..... 282
Barker, F., Secondary batteries..... 207
——— —, to prepare Memoir on W. B. Rogers..... 627
Bartlett, J. R., Deep-sea soundings and temperatures in the Gulf Stream off the Atlantic coast, taken under the direction of the U. S. Coast and Geodetic Survey..... 349
——— — —, Siemens' electrical deep-sea thermometer..... 221
Bateman, F. F., Title of paper..... 321
Beal, W. J., Motions of roots and radicles of Indian corn and of beans..... 466
Beams, spruce, strength of..... 311
Beans and Indian Corn, roots and radicles of,..... 466
Bell, A. G., Electrical experiments to determine the location of the bullet in the body of the late President Garfield; and upon a successful form of induction balance for the painless detection of metallic masses in the human body..... 151

Digitized by Google

	PAGE
Bell, A. G., Paper by	624
——— — —, Proposed method of producing artificial respiration by means of a vacuum jacket	224
——, A. M., Lecture by	626
Benzole, Constitution of	286
Bessey, C. E., Action of frost upon leaf-cells	464
Bickmore, A. S., Title of paper	612
Binocular union of spectral images	149
Bishop of Montreal, Invocation by	613
Bituminous matter, Source of	373
Blackwell, A. B., Cross heredity from sex to sex	492
Blake, C. J., Title of paper	496
Blood corpuscles in bone-manure, Development	512
——, Microcytes, in, Probable origin	512
——, Third corpuscular element in	511
Bolton, H. C., Address, Vice President, Section C	229
—— —— —, Application of organic acids to the examination of minerals	271
—— —— —, Title of paper	292
Bowditch, H. P., Illusions of motion	489
Bowers, V. K., Title of paper	595
Brains, Preparation of, by Giacomini's method	491
Brewer, W. H., Apparent size of magnified objects	139
Britton, N. L., Post-tertiary deposit containing impressions of leaves, in Cumberland County, New Jersey	357
Brooks, W. K., Titles of papers	495
Bross, William, Title of paper	420
Brush, G. J., Address of	1
—— ——, Opens the meeting	613
Buckhout, Wm. A., Gall-mites, Phytoptus	473
Bunsen flame, Modifications of the spectrum of sodium vapor in	218
Burrill, J. T., Some vegetable poisons	515
Caffeine in tea	287
Calcite, Crystals of	419
Caldwell, G. C., Pemberton's method for the volumetric determination of phosphoric acid	289
Canadian Devonian, Fishes in	353
Canadian Palæozoic floras	415
Carbon dioxide in atmosphere	276
Carmichael, Henry, Instrument for readily producing low temperatures	223
——— ——, Title of paper	292
Carpenter, W. B., Lecture by	630
—— — —, Remarks by	627
Cash account of Permanent Secretary	643
Census of 1880	611
Chances, Experimental solution of a problem in the doctrine of	110
Chase, P. E., Conservation of solar energy	108
—— — —, Title of paper	225
Chemical indices	623, 624
——— literature, Committee	627
Chief deities in American religions	573
Chords, Arithmetic of	105
Chrysopa, Mouth of the larva	477
Clark, John, Level invented by	102
Clava leptostyla, Ag., Development of the Planula	527
Claypole, E. W., Titles of papers	420, 495

Digitized by Google

PAGE
Clematis, Revision of 463
Climates 367
Colorado, Silicified stumps of 398
Committee, Local, Minneapolis Meeting xv
———— ———, Montreal Meeting xi
Committees, Reports of 625, 626
Committees, Special xvi
Communications, Titles, ... 124, 225, 292, 321, 419, 495, 528, 594, 612
Compositæ, Achenial hairs and fibres 463
Constitution xxiii
————, Proposed amendment to 633
Cook, E. H., Carbon dioxide as a constituent of the atmosphere 276
——— — —, Simple laboratory device 281
———, G. H., Change of relative level of the Ocean and the Uplands of the eastern coast of North America 400
Cope, E. D., Classification of the Ungulata 477
——— ———, Fauna of the Puerco Eocene 479
Crampton, C. A., Estimation of dextrose in solid commercial starch sugar by loss of rotatory power on solution 285
Crevier, J. A., Title of paper 496
Crosby, W. O., Classification and origin of joint structures 400
Cross and Crucifix 572
Cryptobranchus, Habits of 482
Currant saw-fly, Egg-parasite of 471
Currents of air and Ocean 367
Currier, J. McNab, Title of paper 595
Cylinders, Strength of 317

Dabney, C. W., jr., Titles of papers 292
Dall, W. H., Address, Vice President, Section F 423
Darwin, Memorial to 625
Darwin's theory of the earth-moon system 89
Davenport tablets 584
Dawson, J. W., Comparative view of the successive palæozoic floras of Canada 415
——— — —, Remarks by 616, 628, 635, 639
——— — —, Remarks on taking the Chair 613
Deceased Members lxxviii
——— ———, Notices of 618
Deep-sea soundings 349
De Hass, Wills, Titles of papers 594
Devonian fishes in Canada 353
Dextrine 285
Dextrose 283
Dhegiha, Kinship system and marriage laws 579
Dodge, J. R., Statistics in Agriculture 599
Dolbear, A. E., Titles of papers 225, 226
Dorsey, J. O., Kinship system and marriage laws of the Dhegiha, illustrated by charts 579
———, Titles of papers 594, 612
Douglass, A. E., Find of ceremonial weapons in a Florida mound, with brief notice of other mounds in that state 585
Dudley, William, Title of paper 292
Dwight, W. B., Recent investigations and palæontological discoveries in the Wappinger limestone of Dutchess and neighboring counties, New York state 384

Digitized by Google

PAGE

Earth-moon system, New views of Darwins' theory 89
Eastern coast of North America, Change of level 400
Eddy, H. T., Radiant heat an exception to the second law of thermodynamics 225
Edmands, J. R., Title of paper 612
Edwards, W. H., Titles of papers 496
Electrical experiments to determine the location of the bullet in the body of President Garfield 151
Electric spark, Vision by the light of 148
Elliott, A. H., Titles of papers 292
——— E. B., Titles of papers 612
Ellis, W. H., Some tea analyses, with special reference to the determination of caffeine 287
Elm-leaf beetle 472
Elsberg, Louis, Plant-"cells" and living matter 511
Excursions 625, 635, 639

Fauna of the Puerco Eocene 449
Feldspars, Determination of 257
Fellows lxiv
——— elected 628
Filtering Wash-bottle 525
Fishes, Devonian of Canada 353
Fletcher, A. C., Sun dance of the Ogalalla Sioux 580
——— — —, Title of paper 595
Flora of North America 449
Floras, Palæozoic 415
Florida, Mounds in 585
Foreign guests 619
Fracture, Law of 337
Frost, Action of on leaf-cells 464
Fruits, Diseases of 519
Functions, Inverse elliptic, and the imaginary period 107

Galeruca, xanthomelæna 472
Gall-mites 473
Gamopetalæ, Position of 460
Garfield, President, Electrical experiments to determine the location of bullet in the body of 151
Gatschet, A. S., Chief deities in American religions 573
General Secretary, Report 613
Geological history of the American continent 29
Giacomini's method for preparing brains 491
Gilbert, J. W., Title of paper 292
Glacial flood of the Connecticut River Valley 325
Gladding, T. S., Titles of papers 292
Graham, C. H., Title of paper 420
Graptolites in Niagara formation of Canada 363
Gray, Asa, Flora of North America 449

Haight, S., Title of paper 225
Hale, Horatio, Indian migrations as evidenced by language 578
Haliburton, R. G., Mount Atlas and its traditions 559

Digitized by Google

	PAGE
Hall, Asaph, Parallax of α Lyræ and 61 Cygni	93
—— E. H., Title of paper	226
—— G. S., Illusions of motion	489
—— James, Address of, delivered in 1857	29
——— ———, Titles of papers	419
Hamilton, W. E., New method of graphically expressing any cyclical fact in Meteorology	121
Hanaman, C. E., Filtering wash-bottle especially adapted to the use of the histologist	525
Hare, R. B., Association of crystals of quartz and calcite in parallel position	419
Harkness, William, Address, Vice-President, Section A	77
Hart, C. P., Arithmetic of chords	105
Hastings, C. S., Modifications of the spectrum of sodium vapor in a Bunsen flame	218
Haughton, Samuel, New views of George H. Darwin's theory of the evolution of the earth-moon system, considered as to its bearing on the question of the duration of geological time	89
Heredity, Cross, from sex to sex	492
Heteropora, Recent species from Strait of Juan de Fuca	481
Hingston, W. H., Title of paper	595
Histology of uterine fibroid tumors	513
Hitchcock, C. H., Glacial flood of the Connecticut River Valley	325
Honorary Fellow	lxiv
Hough, F. B., Titles of papers	612
Hovey, H. C., Paper by	623
——, —— —, Subterranean map-making	345
Hoy, P. R., Titles of papers	594
Hunt, G. J., Address	622
——, T. S., Address of welcome	613
—— — —, Chairman of Local Com., Notices by	618, 622
—— — —, Remarks by	618, 634
—— — —, Titles of papers	419
Hurlbert, J. B., Currents of air and ocean in connection with climates, regions of summer rains and summer droughts	367
Hyatt, James, Title of paper	612
Iles, George, Title of paper	225
Indian corn and beans, roots and radicles of	466
Indian migrations as evidenced by language	578
Indicator attachment for high speeds	316
Induction balance	151
Injection apparatus, New form of	521
Insecticides	469
International Geological Committee	634
———— Scientific Association	624
———— Standard Time, Committee	634
James, J. F., Revision of the genus Clematis of the United States	463
Johnson, W. W., Circular Coördinates and Complex Anharmonic Ratios	106
——— — —, Inverse elliptic functions and the imaginary period	107
Joint-cracks, Origin of	417
Joint structures, Classification and origin	409
Julien, A. A., Titles of papers	419, 420

Digitized by Google

PAGE

Kinnicutt, L. P., Action of water at 100° C. on the B phenyltribrompropionic acid 281
Kinship system and marriage laws of the Dhegiha 579
Kitsee, Isidore, Title of paper 292
Kœnig, Rudolph, Title of paper 226
Kowalevsky, D. W., Title of paper 420

Laboratory device 281
Lake Ontario, Ancient terraces of 359
Langley, S. P., Title of paper 225
Lanza, Gætano, Transverse strength of large spruce beams 311
Lawes, J. B., Title of paper 292
Laws and Gilbert, Vote in relation to paper by 633
Leaf cells, Action of frost 464
Leaves in the Post-tertiary of New Jersey 357
Leeds, A. R., Preliminary notice of a new organic base 284
Lepidoptera, New Sexual character in pupæ of 470
L'Etoile, J. de, Aërial navigation 318
Level, New form of 102
Lewis, H. C., Great Terminal Moraine across Pennsylvania 389
Libbey, William, jr., New form of constant pressure injection apparatus 521
Lilly, William, Made patron 618
Lintner, J. A., Egg-parasite of the Currant saw-fly, Nematus ventricosus 471
——— ——, New sexual character in the Pupæ of some Lepidoptera 470
Local Committee, Reception by 622
Lockwood, Samuel, Mastodon Americanus in a beaver meadow, New York 365
Lynch, W. H., Future of the balloon as a practical means of aërial travel 319

Mabery, C. F., Action of baric hydrate on chlorobrompropionic acid 282
——— ——, Certain substituted acrylic and proprionic acids 283
——— ——, Products of the distillation of wood at low temperatures 284
Macloskie, G., Achenial hairs and fibres of Compositæ 463
———— —, Observations on the Elm-leaf beetle, Galeruca xanthomelæna 472
Magnetic ore in Ontario 413
Maltose 285
Mammals, Placental development in 483
Marcy, H. O., Histology of uterine fibroid tumors 513
——— ——, Placental development in Mammals: a unity of anatomical and physiological modality in all vertebrates 483
Marriage laws of the Dhegiha 579
Marsden, Samuel, Experiments to determine the strength of cylinders with domes attached 317
Mason, O. T., Title of paper 594
Mastodon Americanus, Discovery of, in New York 365
Mayor of Montreal, Welcome from 616
McCook, H. C., Title of paper 496
Meehan, Thomas, Address of 437
Meetings of the Association xx
——— —— ——— of Geologists and Naturalists xix
Members xxxi
Mendenhall, T. C., Address, Vice President, Section B 127
———— ——, Experimental solution of a problem in the doctrine of ——— ——, chances 110
———— ——, Title of paper 226
Menzel, F., Title of paper 292
Merritt, W. H., Occurrence of magnetic ore deposits in Victoria Co., Ontario 413

Digitized by Google

	PAGE
Metal, Linear elasticity	118
Meteorology, Cyclical fact in	121
Microscopic Club	623, 626
Mills, T. W., Title of paper	496
Minneapolis, Invitation from	627
——— Meeting, Local Committee	xv
——— ——— Officers	xiii
——— ——— ——— elected for	634
——— ——— Standing Committee	xiv
———, Voted to hold meeting at	628
Mineralogists, List of	21
Mineralogy, Sketch of the progress of	1
Minerals, List of, in the United States and Canada	21
Mixter, C. S., Facts relative to the U. S. census of 1880	611
Montreal Meeting, Local Committee	xi
——— ——— Officers	ix
——— ——— Standing Committee	x
Moraine, Terminal, across Pennsylvania	389
Motion, Illusions of	489
Mounds in Florida	585
Mount Atlas and its traditions	539
Nematus ventricosus, Egg-parasite of	471
Newberry, J. S., Titles of papers	420
Newton, Sir Isaac, Corrections of problem of	109
New York, Undulations of rock-masses	412
—— ——— Wappinger limestone	384
Niagara formation of Canada, Graptolites in	363
Nichols, E. L., Duration of color-impressions upon the retina	146
North America, Change of level of eastern coast	400
North America, Flora of	449
Objects, magnified, apparent size of	139
Officers elected for Minneapolis Meeting	634
——— Minneapolis Meeting	xiii
——— Montreal Meeting	ix
Ogalalla Sioux, Sun dance	580
Ohio, Black Shales, source of Bituminous matter in	373
Oliver, J. E., Method of finding the law of linear elasticity in a metal	118
——— —, On the law of distribution for certain plant-numbers	117
Ontario, Magnetic ore	416
Order of Proceedings in organizing Meeting	xxx
Organic acids, Application of	271
——— base, Notice of	284
——— compounds in their relations to life	493
Organisms, Classification of,	494
Orton, Edward, Source of the bituminous matter in the Black Shales of Ohio	373
——— ———, Title of paper	420
Osborn, H. F., Title of paper	496
Osler, William, Demonstration of a series of brains prepared by Giacomini's	
—— ———, method	491
—— ———, Development of blood corpuscles in the bone-marrow	512
—— ———, Microcytes in the blood and their probable origin	512
—— ———, Third corpuscular element in the blood	511
—— ———, Title of paper	528

Digitized by Google

PAGE
Ottawa Excursion..... 625
Owen, Richard, Contribution to seismology..... 329
——— ———, Law of fracture, or fissuring, applied to inorganic and organic matter..... 337

Palæozoic floras of Canada..... 415
Palmer, G. M., Action of water at 100° C. on the B phenyltribrompropionic acid..... 281
Parallax of α Lyræ and 61 Cygni..... 93
Parkhurst, H. M., Bell attachment for telescope circles..... 111
Patrons..... xxxi
Pemberton's method for the volumetric determination of phosphoric acid.... 289
Penhallow, D. P., Structural and physiological peculiarities incident to the
——— ——— — —, diseases of fruits..... 519
——— ——— — —, Title of paper..... 225
Pennsylvania, Moraine across..... 389
Perkins, G. H., Recent archæological discoveries in Vermont..... 592
——— — —, Title of paper..... 594
——— — —, Winooski marble of Vermont..... 388
Permanent Secretary, Cash Account..... 642
——— ———, Notices by.....617, 618, 622, 630, 635
——— ———, Report..... 640
Petroleum, Value as insecticides..... 469
Phené, J. H., Some hitherto unnoticed affinities between ancient customs in America and the other Continents..... 569
Phosphoric acid, Volumetric determination..... 289
Phytoptus..... 473
Pillsbury, J. H., Development of the Planula of Clava leptostyla, Ag..... 527
Placental development in Mammals..... 483
Plant-"cells" and living matter..... 511
Plant-numbers, Law of distribution..... 117
Population of United States..... 611
Post-tertiary deposit, Cumberland county, New Jersey..... 357
Preglacial channel of Eagle River, Michigan..... 352
President, Address of..... 1
Primary Meridian, Committee on..... 634
Proceedings, Subscriptions for reprinting volumes of..... 618
Prodoxus, Peculiarities in..... 467
Pronuba, Peculiarities in..... 467
Puerco Eocene, Fauna of..... 479
Putnam, F. W., Report of Permanent Secretary..... 64
——— — —, Titles of papers..... 595

Quartz, Crystals of..... 419
Quebec excursion..... 625

Rae, John, Title of paper..... 420
Rain-band, Spectroscopic..... 145
Ratios, Complex anharmonic and circular coördinates..... 106
Rau, Charles, Title of paper..... 595
Reception by Dr. and Mrs. Dawson..... 623
——— — Local Committee..... 622
——— —— Mr. and Mrs. Gault..... 633
——— —— —— —— —— Mackay..... 633
——— —— —— —— —— Molsom..... 625
——— —— —— —— —— Sargent..... 626

Digitized by Google

	PAGE
Records of Science	624
Redpath Museum, Opening of	623
Religions, American, Chief deities	573
Report of General Secretary	613
Report of Permanent Secretary	640
Resolutions of Thanks	635
Respiration, Artificial	224
Retina, Durations of color-impressions	146
Riley, C. V., Emulsions of petroleum and their values as insecticides	469
——— — —, Hibernation of Aletia xylina (Say), in the United States, a settled	
——— — —, fact	468
——— — —, Observations of the fertilization of Yucca, and on structural and anatomical peculiarities in Pronuba and Prodoxus	467
Robinson, F. C., Certain substituted acrylic and propionic acids	283
——— S. W., Title of paper	225
Rock-masses, Undulations of	412
Rockwell, C. H., Title of paper	124
Rogers, W. A., Method of reducing different catalogues of stars to a homoge-	
——— — —, neous system	99
——— — —, Performance of a new form of level invented by John Clark	102
——— — —, Titles of papers	226, 528
——— W. B., Memoir to be prepared	627
——— — —, Resolutions on	524
Rowland, H. A., Title of paper	226
Rust, H. N., Davenport tablets	584
——— — —, Title of paper	594
Sands, Fred., Title of paper	292
Saunders, William, Mouth of the larva of Chrysopa	477
——— ——— Report of General Secretary	613
Screws of increasing pitch, Method of cutting	314
Seaman, W. H., Title of paper	496
Secondary batteries	207
Sections, Officers and committees of	620, 623, 624
Seismology, Contribution to	329
Siemens' electrical deep-sea thermometer	221
Silicified stumps of Colorado	398
Silliman, W. A., Title of paper	496
Siphonotreta Scotica	356
Smiley, C. W., Exhibition of some statistics of college men	607
——— — ——, Methods and results of collecting statistical matter by mail	601
Smith, E. A., Titles of papers	595
Smock, J. C., Title of paper	420
Solar energy, Conservation of	108
Southeastern Railway, Excursion given by	639
Spencer, J. W., Occurrence of Graptolites in the Niagara formation of	
——— — —, Canada	363
——— — —, Terraces and beaches about Lake Ontario	359
Standard Time, Report from Section I	633
Standing Committee, Minneapolis Meeting	xiv
——— ———, Montreal Meeting	x
Starch-sugar	285
Stars, Reducing different catalogues	99
Statistical matter, Methods and results of collecting by mail	601
Statistics, Agricultural	599
——— of college men	607
Steam, Limit to expansion	307

Digitized by Google

PAGE

Stearns, R. E. C., Title of paper..... 496
Stevens, W. LeConte, Binocular union of spectral images..... 149
——— —— ———, Vision by the light of the electric spark..... 148
Stillwell, C. M., Title of paper..... 292
Subterranean map-making..... 345
Sun dance of the Ogalalla Sioux..... 580
Szabó, J., New microchemical method of determining the feldspars in rocks 257

Taylor, Thomas, Titles of papers..... 528
Tea Analyses..... 287
Telescope circles, Bell attachment for..... 111
——— Hulsted Observatory..... 112
Temperature, low, Instrument for readily producing..... 223
Temperature of the Deep-sea, Lecture by Dr. Carpenter..... 630
Terraces and beaches about Lake Ontario..... 359
Thermodynamics..... 225
Thermometer, Siemens' electrical deep-sea..... 221
Thornburn, Dr., Remarks by..... 616
Thurston, R. H., Newly discovered absolute limit to economical expansion in the steam engine and in other heat-motors..... 307
Titles of communications,..... 124, 225, 292, 321, 419, 495, 528, 594, 612
Tobin, T. W., Title of paper..... 292
Transit observations, Personal equation..... 118
Trouvelot, E. L., Astronomical drawings by..... 623
Trowbridge, W. P., Address, Vice President, Section D..... 295
Tumors, Fibroid, Histology..... 513
Tuttle, A. H., Address, Vice President, Section G..... 499
——— —— ——, Title of paper..... 528

Ungulata, Classification of..... 477
Upton, Winslow, Spectroscopic rain-band..... 145
——— ———, Title of paper..... 612
Utica formation near Ottawa..... 356

Vacuum jacket..... 224
Van der Weyde, P. H., Title of paper..... 124, 226
Variations in Nature..... 437
Vegetable poisons..... 515
Vermont, Archæological discoveries, in..... 592
——— Marble..... 388
Vice President Bolton, Address..... 229
—— ——— Dall, Address..... 423
—— ——— Harkness, Address..... 77
—— ——— Mendenhall, Address..... 127
—— ——— Trowbridge, Address..... 295
—— ——— Tuttle, Address..... 499
—— ——— Wilson, Address..... 531

Walling, H. F., Origin of Joint cracks..... 417
Wappinger limestone of New York..... 384
Ward, L. F., Classification of Organisms..... 494
——— ——, Organic compounds in their relations to life..... 493
——— ——, Position of the Gamopetalæ..... 460

Digitized by Google

PAGE

Warder, R. B., Silicified stumps of Colorado 398
——— — —, Title of paper 292
Warner, J. D., Title of paper 226
Water, Action of at 100° C 281
Watson, Screno, Title of paper 496
Wead, C. K., Mean-direction integrating anemometer 147
Webb, J. B., Indicator Attachment for high speeds 316
——— — —, Method of cutting screws of increasing pitch 314
Webb, J. B., Method of eliminating the personal equation in transit observations 118
Wheeler, C. G., Title of paper 292
Whiteaves, J. F., Note on the occurrence of Siphonotreta Scotica (Davidson) ——————— — —, in the Utica formation near Ottawa, Ont 356
——————— — —, Recent discoveries of fossil fishes in the Devonian rocks of ——————— — —, Canada 353
——————— — —, Recent species of Heteropora from the Strait of Juan de Fuca 481
Whitehouse, F. C., Title of paper 420
Whittlesey, Chas., Cross and the crucifix 572
——————— ———, Preglacial channel of Eagle River, Michigan 352
Wilder, B. G., Habits of Cryptobranchus 482
Wiley, H. W., Direct estimation of dextrose, dextrine and maltose in com- ——— — —, mercial amylose (starch sugar) 285
——— — —, Estimation of dextrose in solid commercial starch sugar by loss of rotatory power on solution 285
Williams, H. S., Undulations of the rock-masses across central New York State 412
Wilson, Daniel, Address, Vice President Section H 531
———, Ralph, Action of baric hydrate on chlortribrompropionic acid 282
Winooski Marble of Vermont 388
Wood, De Volson, Correction of a problem in "The system of the world," by ——— — ———, Sir Isaac Newton 109
——— — ———, Title of paper 225
Wood, Distillation of 284

Young, C. A., Twenty-three inch telescope of the Halsted Observatory at Princeton 112
Yucca, Fertilization of 467

Digitized by Google

Digitized by Google

Digitized by Google

Digitized by Google

Digitized by Google

UNIVERSITY OF CALIFORNIA
BRANCH OF THE COLLEGE OF AGRICULTURE

THIS BOOK IS DUE ON THE LAST DATE
STAMPED BELOW

1m-5,'30

Digitized by Google

10606 Q11
American association A6
for the advancement of 1882
science. pt.2
Proceedings.

Q11
A6
1882
pt.2

10606
LIBRARY, BRANCH OF THE COLLEGE OF AGRICULTURE

Digitized by Google

PUBLICATIONS

FOR SALE BY THE

American Association for the Advancement of Science.

TRANSACTIONS OF THE ASSOCIATION OF AMERICAN GEOLOGISTS AND NATURALISTS, 1st, 2nd and 3d Meetings, 1840–1842, in one volume. 8vo, cloth, 544 pages, 21 plates, 1843, $3.00. Half Turkey morocco, $4.50.

MEMOIRS OF THE AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE. 4to. No. 1, *Fossil Butterflies.* By S. H. Scudder. 100 pages, 3 plates, 1875. Paper covers, $2.00. Half Turkey morocco, $3.50.

PRESIDENTIAL ADDRESSES, 8 vo, pamphlets. Copies of such as can be supplied are furnished at 25 cents each.

REPORT OF THE COMMITTEE ON ZOOLOGICAL NOMENCLATURE, 8vo. pp. 56. Nashville Meeting, 1877. 25 cents.

PROCEEDINGS OF THE AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE. 8vo, paper. With numerous illustrations.

Vol.	I.	Philadelphia	Meeting,	1848,	pages	156,	published 1849.
	II.	Cambridge	"	1849,	"	479,	" 1850.
	III.	Charleston	"	1850,	"	239,	" 1850.
	IV.	New Haven	"	1850,	"	449,	" 1851.
	V.	Cincinnati	"	1851,	"	287,	" 1851.
	VI.	Albany	"	1851,	"	480,	" 1852.
	VII.	Cleveland	"	1853,	"	312,	" 1856.
	VIII.	Washington	"	1854,	"	372,	" 1855.
	IX.	Providence	"	1855,	"	357,	" 1856.
	X.	2nd Albany	"	1856,	"	547,	" 1857.
	XI.	Montreal	"	1857,	"	447,	" 1858.
	XII.	Baltimore	"	1858,	"	376,	" 1859.
	XIII.	Springfield	"	1859,	"	444,	" 1860.
	XIV.	Newport	"	1860,	"	328,	" 1861.
	XV.	Buffalo	"	1866,	"	174,	" 1867.
	XVI.	Burlington	"	1867,	"	218,	" 1868.
	XVII.	Chicago	"	1868,	"	410,	" 1869.
	XVIII.	Salem	"	1869,	"	352,	" 1870.
	XIX.	Troy	"	1870,	"	427,	" 1871.
	XX.	Indianapolis	"	1871,	"	491,	" 1872.
	XXI.	Dubuque	"	1872,	"	339,	" 1873.
	XXII.	Portland	"	1873,	"	669,	" 1874.
	XXIII.	Hartford	"	1874,	"	378,	" 1875.
	XXIV.	Detroit	"	1875,	"	541,	" 1876.
	XXV.	2nd Buffalo	"	1876,	"	424,	" 1877.
	XXVI.	Nashville	"	1877,	"	456,	" 1878.
	XXVII.	St. Louis	"	1878,	"	424,	" 1879.
	XXVIII.	Saratoga	"	1879,	"	636,	" 1880.
	XXIX.	Boston	"	1880,	"	875,	" 1881.
	XXX.	Cincinnati	"	1881,	"	504,	" 1882.
	XXXI.	2nd Montreal	"	1882,	"	743,	" 1883.

Price of the Proceedings $1.50 a Volume, or to Members ordering ten or more Volumes at one time, $1.00.

[Volume XXVII is being reprinted.]

Orders will be received for any of the above volumes of Proceedings, bound in full cloth, at 50 cents extra per volume; or in half Turkey morocco, at $1.00 extra per volume. Uniform Cloth Covers for the Proceedings, by mail, 30 cents each; or 25 cents by express.

Address: F. W. PUTNAM, Permanent Secretary,

SALEM, MASS.

Digitized by Google